# Architectural Drift: Utilizing Glitch in the Parametric Design Process for Urban Housing

by

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Dalhousie University is located in Mi’kma’ki,
the ancestral and unceded territory of the Mi’kmaq.
We are all Treaty people.

This thesis is dedicated to my family and my partner Delaney Ryan for their unwavering support and confidence in me.

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# Abstract

A common parametric design process relies on geometric rationalization in the early design stage. This reliance constrains the design process. Less explored are moments of post-rationalization in parametric design in response to technical glitches or imperfections. Santiago R. Perez defines this imperfection and its productive use, as ‘Drift’, or ‘loss of control’. This thesis uses Drift in a parametric design process to explore its potential to create diverse, dense housing that promotes post-rationalization by its inhabitants. In doing so, this thesis hypothesizes that imperfection within customization can support adaptations of individual dwelling choice and the specific contingencies of everyday living.

# Acknowledgements

I would like to thank James Forren and Elizabeth Powell for their guidance and support throughout the thesis semesters.

To Marcus, Myrk and Logan, thank you for your feedback and advice.

# Chapter 1: Parametric Architecture

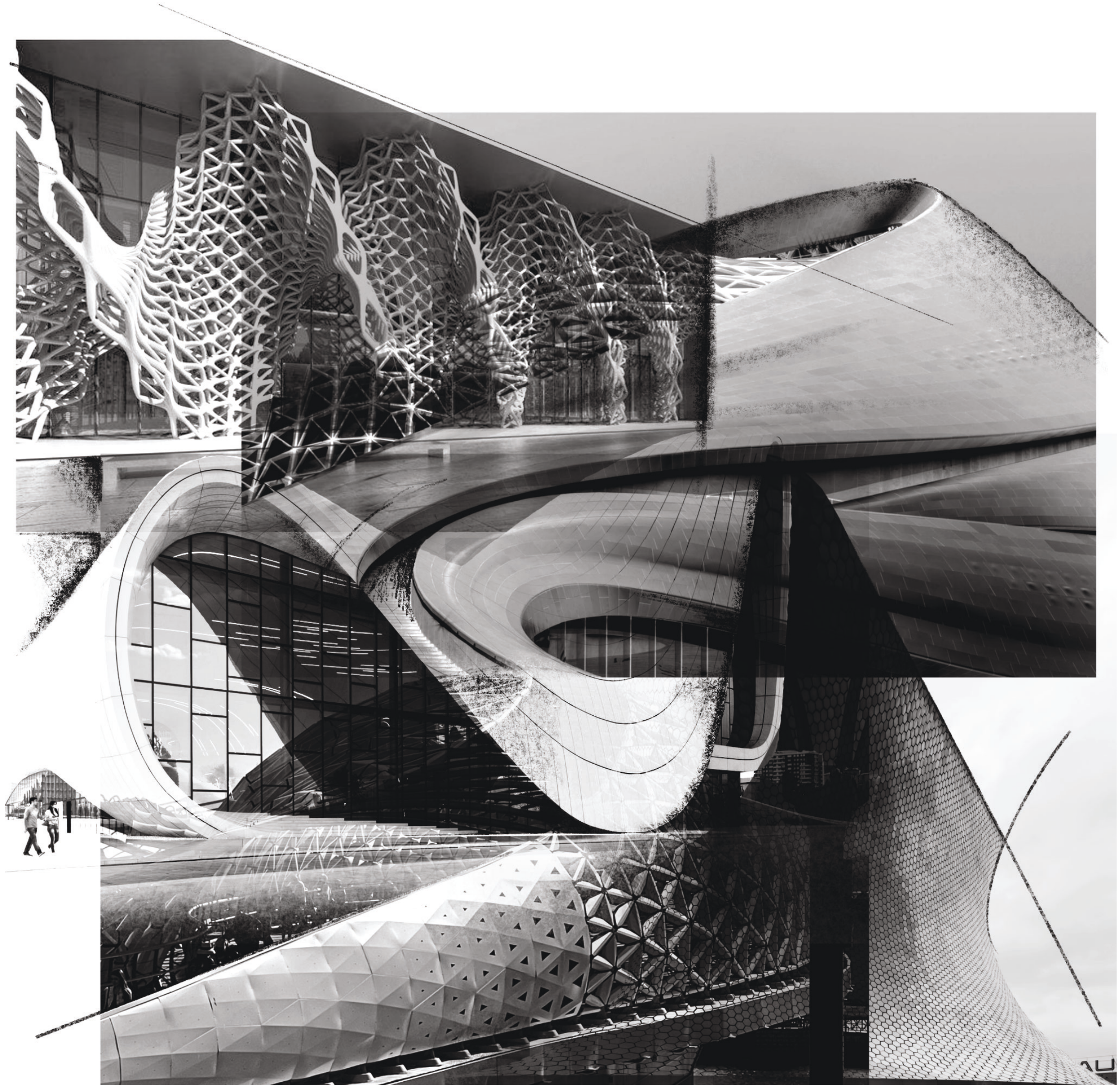
## Defining Parametrics

The term parametric, regarding parametric design and architecture, is often used interchangeably with computational, generative design, and parametricism. These methods of design share similarities, for example the need for an input that can be processed into an output. However, due to the ever-growing eco-system of programs and tools that are available further expanded by the sudden availability of and ease of use that is afforded to the creative mind by Artificial Intelligence prompt-controlled tools such as ChatGPT, it is difficult to clarify if one is referring to parametric, computational, or generative design. For the purposes of this thesis, the primary definition of parametricism will be as follows: “a type of virtual modeling that uses parametric calculation where the “shape” and morphology of “forms” is determined by dynamic and recursive streams of inputs - a capability that can be explored and applied in a large number of extremely different ways” (Poole and Shvartzberg 2015, 6).

## Parametric vs Parametricism

### *Politics and Parametrics*

The word Parametricism was coined by architect and architectural theorist Patrik Schumacher. Schumacher’s position on the political nature of architecture is that architecture cannot be political; his reasoning being that no art or design can be political when there are ways for anyone



Collage of parametric architectural projects.

to become involved with politics through governmental interaction (Poole and Shvartzberg 2015). In saying this, Schumacher (and others who agree with him) are ignoring the fact that the official channels of political influence are in many ways set up to filter out those who would enact great change to them: in order to have any power over the system one must first take part in the system. In doing this, they accidentally (or purposefully) end up preventing change to the existing fabric of the architecture industry, keeping parametric architecture as a commodity or generator of status for the few who can afford it.

### *Against the Antipolitical*

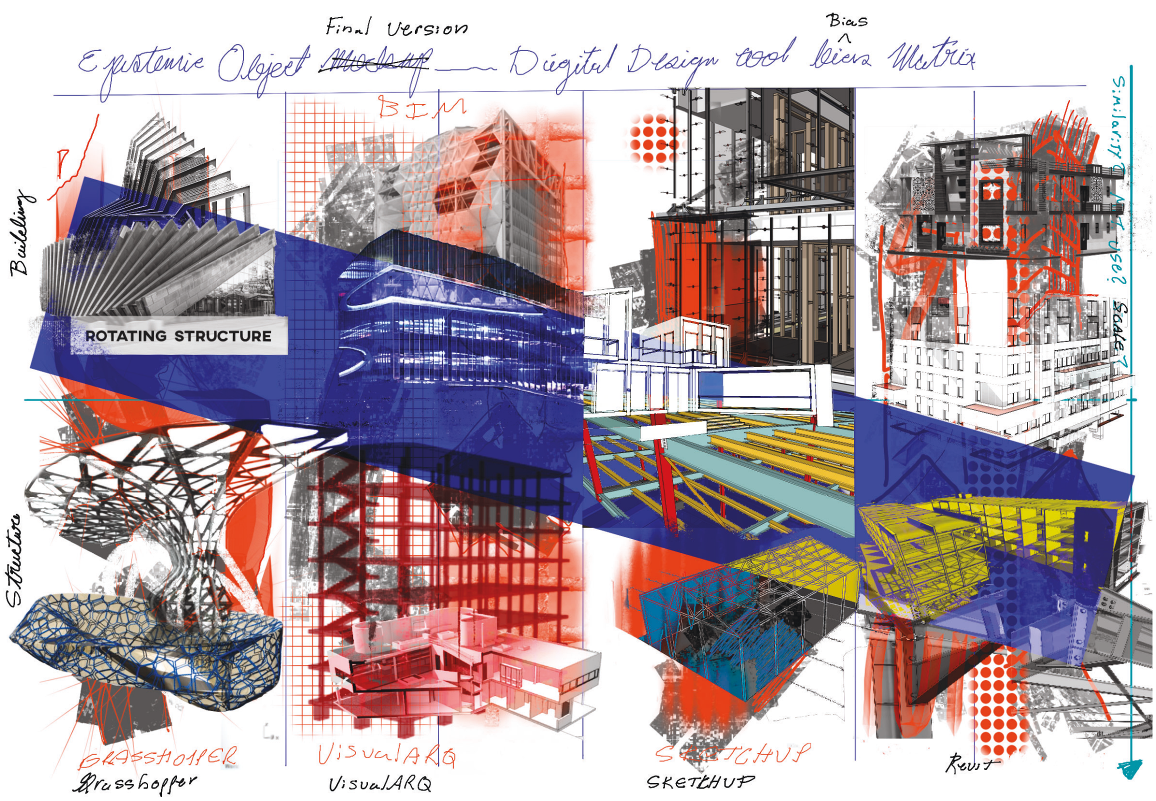
To refuse the political aspect of parametric design stagnates the potential evolution of the architectural process and keeps parametricism as it is instead of working to create a parametric architecture process that can move beyond the formal perfection of its current state. This thesis is set against the antipolitical opinions of Schumacher's parametricism. While accepting of the fact that it is a marvel that any parametrically designed project has been built at all due to the cost of working against the mass production paradigm, the parametric projects designed do not venture beyond the boundaries of geometric and metaphorical rationalization.

# Chapter 2: Design Rationalization

This search for complex forms of buildings is observed all over the world; it is now a challenge among the greatest architectural firms to use parametric design to create new buildings. This technology allows us to overcome the limits of the past and the design of intrepid shapes that release from simple geometric shapes, creating a new contemporary language. It is clear that without a proper cultural and intellectual background it is only a game with shapes (Burlando and Grillo 2019).

## Pre-Determined Form

The term "form" in architecture is one that defies clear definition. Some use it to describe the shape of a building; as a physical descriptor. The modernist architect Louis Kahn




Epistemic Object: a collage of design images gathered from search terms focused on specific 3D digital architecture design programs (Grasshopper, VisualARQ, SketchUp, and Revit).

has a unique and eloquent way of defining form that comes from Louis Kahn: Conversations with Students:

> Form has no shape or dimension. Form merely has a nature and a characteristic. It has inseparable parts. If you take one part away, form is gone. That's form. Design is a translation of this into being. Form has existence, but it doesn't have presence, and design is towards presence. But existence does have mental existence, so you design to make things tangible (Kahn 1998).

Based on this, when Kahn writes "if you take one part away, form is gone", it can then be assumed that Kahn feels a work of architecture is perfect in the moment after construction has been completed, and that there is a definitive "correct" form, one that is pre-rationalized and cannot change and grow without the loss of something integral to the architecture. This way of thinking about an architectural project is present not just in the modernist camp of designers but in contemporary architecture offices today, and is a major contributing factor in a stagnated landscape of otherwise incredible architecture.

## The Significance of Form

As the tools used to design architecture change so must the concepts that drive process and bring form into presence. The complexity of architectural form and structure advances rapidly, and designers must examine concept as a generator in tandem with digital tools to ensure that the design process used is not stagnating the result.

## Modeling Program Influence

The tools that designers use do a great deal of shaping within the architectural process. Just as the physical tools that creators use leave their mark on the created work, the software that architects choose to design with inevitably leave an impression on the building designed. One can assume that tools created for a specific purpose intend to make that purpose, in this case the creation of digital architecture models, easier or more efficient. In order to make a process easier, a tool is likely designed with ease of the standard operations of a creator in mind. The resulting program, with its ease of use in some areas of design and potentially limited use in others, eventually exerts a formal bias on the design. And as most designers create their models just in one program, this can stagnate the potential of a design. This is not an indictment of architects choosing

Overmining: “Display Center in Guangzhou shaped like a half-hyperboloid”, (Nair 2024).

an easier program to use but an intrinsic characteristic in the nature of making. The parametric architectural process needs to be critically examined as a creating process as it grows and becomes more easily buildable via advancing construction techniques. The architectural forms that are made available through parametric tools are extremely varied, but designers still fall into the trap of designing what is more easily modeled, justifying this move with a geometric rationalization.

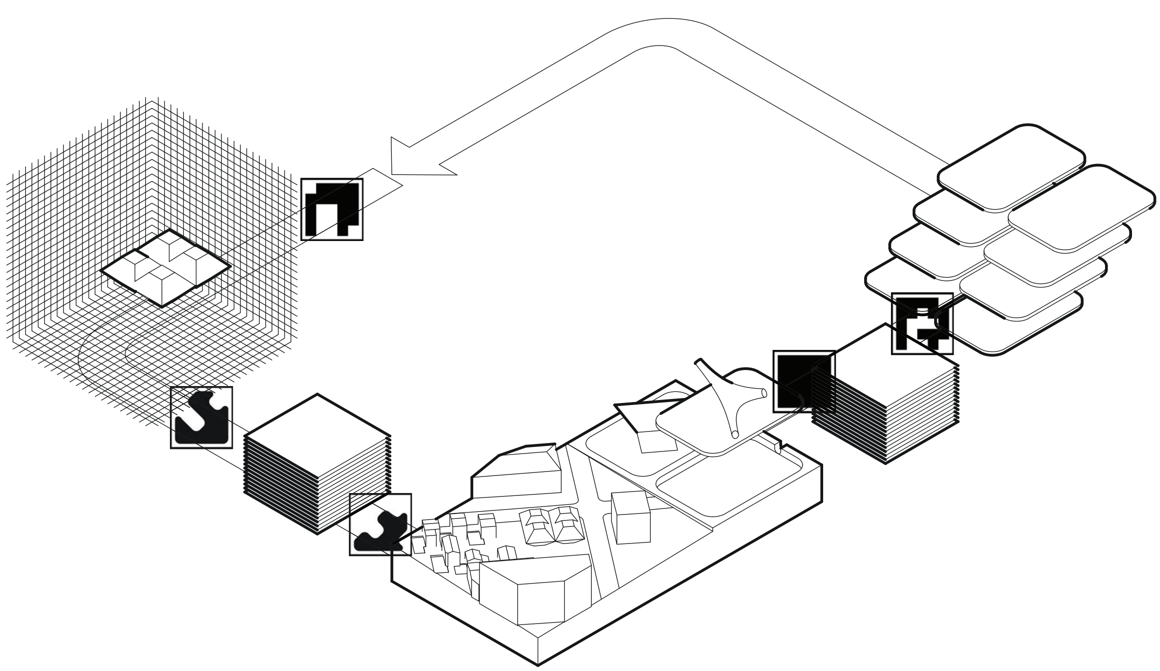
## Geometry and Design Rationale

Through the synthesis of a potentially infinite number of parameters and data sets, the parametric design process provides opportunity for rapidly generated complexity. A common step in this process is the justification for a particular building shape through geometric rationalization, or as Mark Foster Gage puts it, “overmining”. Overmining is the use of simplified metaphor to describe the shape of a building, most often a shape that might have contextual relevance in order to justify the shape of the design (Gage 2015). The act of applying a geometric rationale, metaphorical or not, to a work of architecture aligns with Kahn’s interpretation of form, but it also creates a conceptual box that the designers then need to work within. Adding a formal constraint on top of other potentially mitigating factors such as space limitations or cost only reduces opportunity for emergence as the process of design moves forward beyond the conceptual stage.

# Chapter 3. Drift and Emergence

## Drift

The parametric design process is capable of producing incredibly complex architectural form through the interrelation of inputs and data. However precise and impressive the digital result, the design still has to undergo the rigours of translation into the real, or “from intentionality to contingency” (Perez 2017). At the point of physical manifestation, error occurs. The movement from the dimension of 3D design to reality is what this thesis refers to as Drift, or Drift Points. In addition to the physical realization of a design, there are also digital-to-digital translations. The logic of every digital program is slightly different, from surface modeling to solid modeling, and there are different file formats that read geometry in specific ways. Accordingly, if imperfection is manifesting at Drift Points throughout the design process,

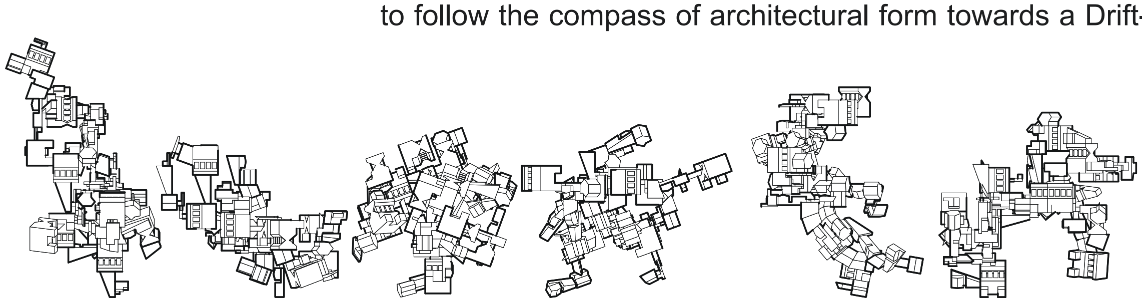


Drift Points: the compounding error that occurs at the moment of design medium translation.

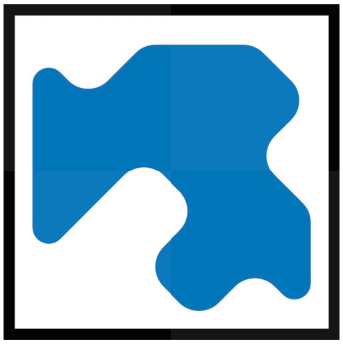
the question is what should designers do with it? Until now, in the age of mass produced architecture and digital modeling, the attempt has been to clamp down on it, and attempt to create more and more perfect architecture with lower and lower manufacturing tolerance. But what if architects embraced Drift instead and figured out a way to fit imperfection and error into architecture? By relinquishing some control within the process, designers can balance the precision of the digital with error and glitch, and work with a fluid system of design (Burry 2012) as opposed to a conceptual geometric artifact.

## The Imperfect Building Already Exists

There are bound to be issues of cohesion between a digital model and the constructed building. The imperfection this thesis discusses already occurs in every architectural process. Designing a building and bringing it into presence exactly as you planned it down to the millimeter is not possible and it never will be. With the economic desire for a maximally efficient architectural process hot on the heels of designers and the already available robotic fabrication, buildings constructed through a collaborative human-robotic workflow will become more and more common instead of mainly existing in the world of architectural pavilion. The more we collaborate with technology in the design process, the more Drift points will occur. Accepting this, it is logical to follow the compass of architectural form towards a Drift-



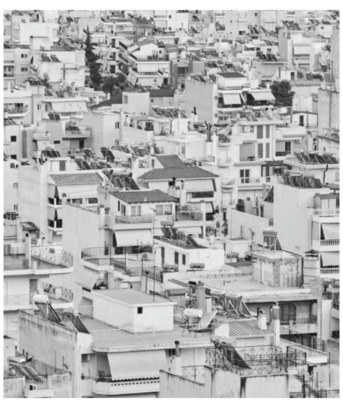
The Parametric Drift Cluster.



Process that fully embraces the error and glitch that will undoubtedly occur, and let it lead us to an architecture that is strengthened by its imperfection.

## Emergence and Drift

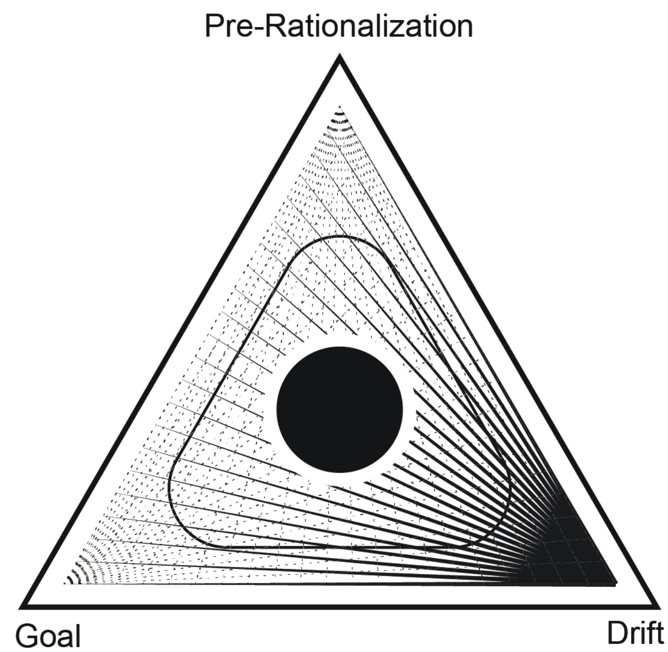
Emergence is a commonly used term in architectural circles, generally as a way of describing actions or alterations created by users taking advantage of the opportunities in their built environment. It is what happens when life meets opportunity, and the lives of people begin to shape their environment. How would a parametrically derived architecture look if it were designed with a Drift focused design process that not only afforded imperfection in the design work but purposefully leaned into an ambiguous imperfection for the final product? A piece of architectural work completed in this way would be revolutionary in a time of false individuality. The ecosystem-scale complexity that is possible through parametric architectural design lends itself perfectly to architecture that has no two rooms the same, allowing for the emergence of real connection between the users and the space. The result would be an imperfect urban fabric constructed to be an aggregated system of housing where people choose where they live based not only on location but the feeling of the individual living pods. What would normally be a breathtakingly expensive custom fabrication project becomes a material economy-optimized collaborative construction project that fully takes advantage of the unique morphologies that parametric process can create in combination with the industry of digital making, an ecosystem of mass customization (Carpo 2023) that even in its infancy has begun to transform the way that we design and create architecture.



The Imperfect Town.

## Drift Compass

If this thesis is arguing that an alternative architectural design process is one of ambiguity and imperfection, it would not be unreasonable to ask how the designer can keep the resulting design from becoming entirely mired in imperfection to the point that it is not possible for the users to rationalize its space. One method is through the use of a Drift Compass, a 3-way graph to be used as a method for the parametric designer to check in with the results of their work. Goal refers to the intention of the parametric tool, for example structural or circulation optimization, or in the case of this project density of housing. The goal is balanced against Pre-Rationalization on one hand, and Drift on the other, the idea being that the designer locates the dot on the graph to represent where the design is at that moment. Every designer would use it differently, which is how it is meant to be; this thesis is not setting out a strict set of rules for parametric design but rather an alternative influence and perspective.



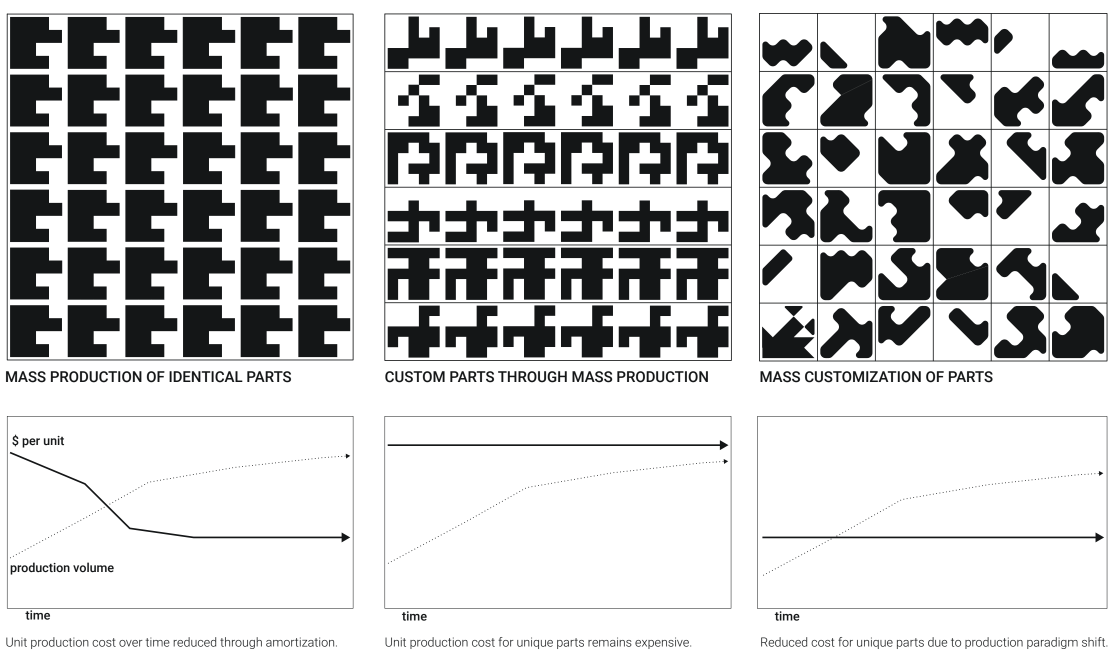

Drift Compass.

# Chapter 4. Digital Production

## The Relationship between Parametrics and Digital Production

The cost of parts production exerts a strong influence on architecture due to the financial limits that constrain most projects. Although this has been the case since the inception of mass production, it will not always be so. Mass production is based on the concept of amortization (spreading out the upfront cost over time) of a piece of machinery that is intended to create a singular component or set of pre-determined components. This makes it more affordable to be designing and building with the same pieces, and extremely expensive to get custom parts made (Carpo 2023).

Production paradigms are changing, and digital production is on the rise. Digital production refers to any production that is based on the logic of computers: a common example




The relationship between production paradigm and architectural component cost.

being 3D printing. Robotic fabrication disrupts the norm of production in several key ways. Because it does rely on a form or stamp like mass production techniques, there is nothing that needs to be amortized. Effectively this means a 3D printing facility could be producing parts that are each entirely unique without much deviation in the price of each component. Following this logic brings us to the connection between parametric architecture and this new and growing production paradigm. As the availability of irregular and complex architectural form becomes democratized through changing production methods, it will become easier to fully realize the architectural forms created using parametric process. This makes it extremely important to thoroughly investigate the intentions and results of parametric architecture, and strive to find a way of working with it that effectively utilizes the complexity of parametric design while bettering the built environment for its inhabitants.

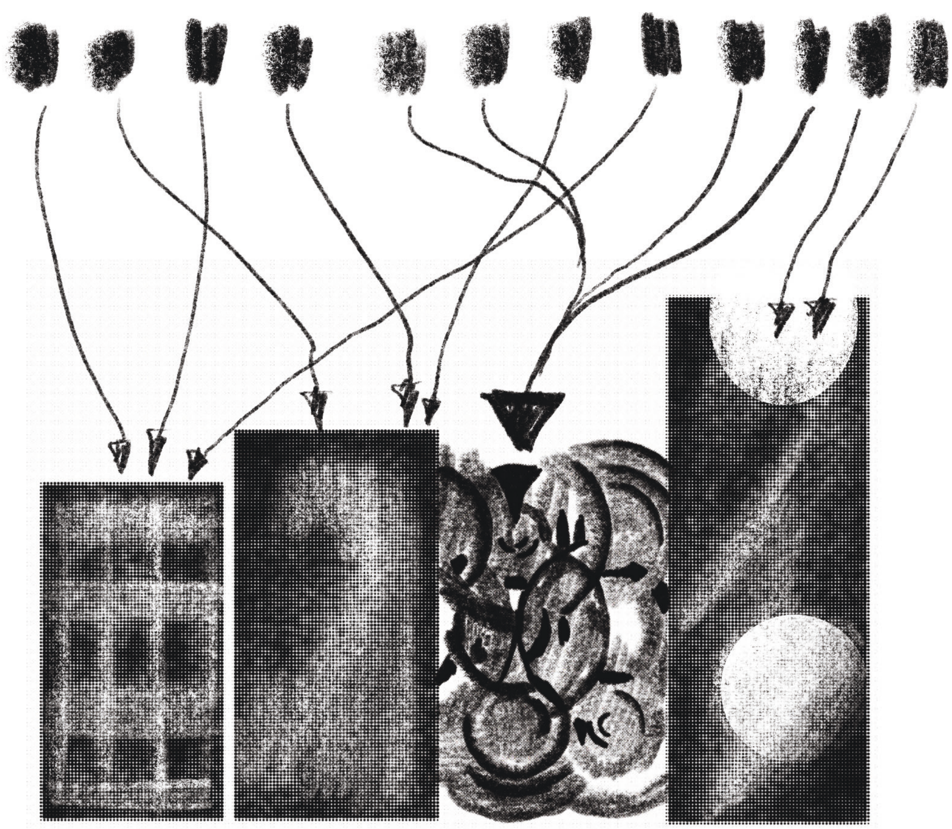
Early design process parametric massing test.

# Chapter 5: Dwelling and Choice

> As homo viator, he is always on the way, which implies a possibility of choice. He chooses his place, and hence a certain kind of fellowship with other men (Norberg-Schulz 1998).

## Choosing a Dwelling

As Norberg-Schulz writes, the ability to choose a type of dwelling is an integral part of dwelling and existence. The mode of inhabitation of environment and relation to other beings that a person takes part in is the result of this powerful choosing. Everyone makes these choices differently; for example imagine a campsite next to a lake. There will be existing objects at the site, a campfire in the middle perhaps,



Choice in dwelling environment can encourage stronger connection between a person and their environment.

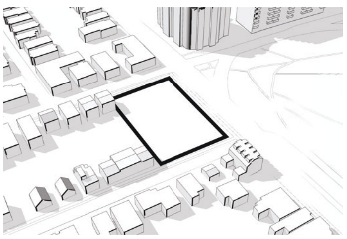
a large flat stone, a series of trees spread. Most campers are going to set up their dwelling for the night in different ways, to suit their personal needs and wants, or just based on instinct: doing what feels right. It seems then that a Drift focused parametric design process capable of creating such complexity and variety, could produce a housing design that provides a similar method of choice in dwelling within the urban environment.

## Customization vs Variation

The previously mentioned changes to component production lends itself well to the creation of housing that diverges strongly from formal norms and creates opportunity for dwelling choice. However, a necessary clarification must be made regarding the difference between customization, as written about by Mario Carpo, and variation of spatial connection and criteria, which is what this thesis focuses on. The intention is not to design housing that has been designed and customized by everyone who would live there. The design will instead attempt to utilize a process that has room for Drift and moves away from geometric rationalization as a primary design motivator. Customization in this case becomes an act that people take part in after the initial inhabitation choice has been made, as they make their mark on their living spaces and become part of the constant alteration and evolution of buildings (Brand 1995).

# Chapter 6: 2170 Robie Street

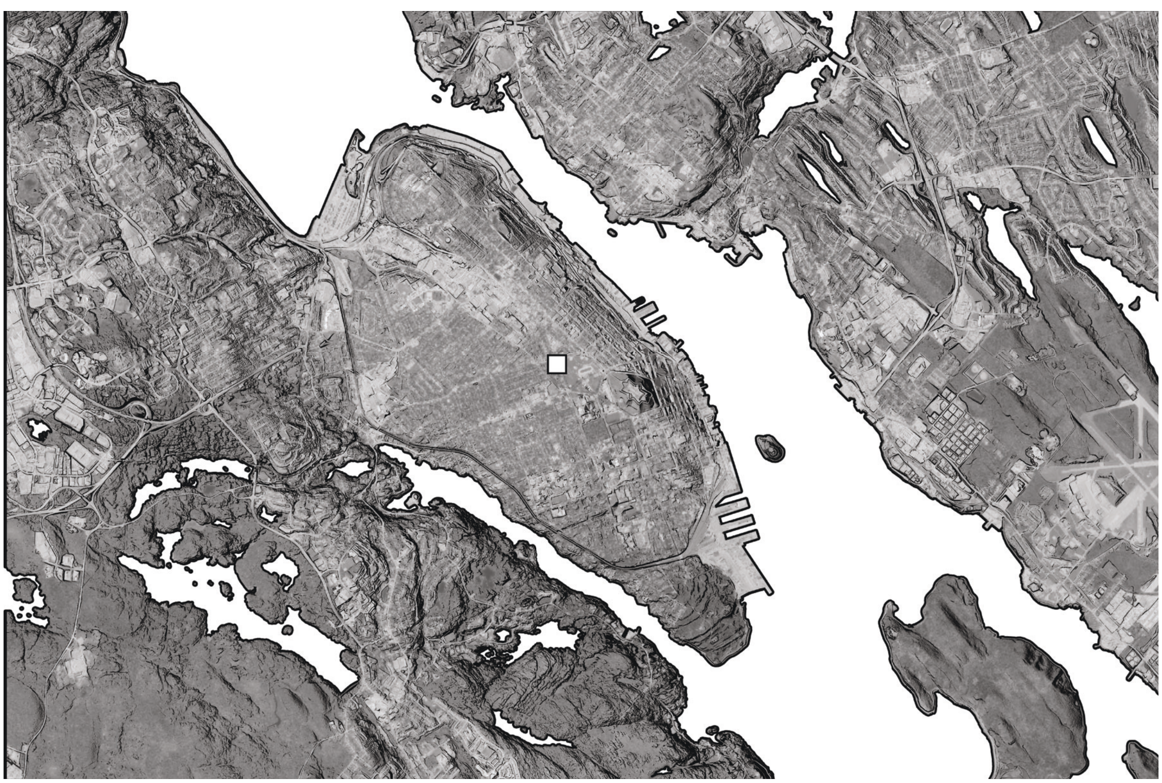
The selected design site for this thesis is 2170 Robie Street in Halifax, Nova Scotia, Canada. At the corner of Cunard Street, Robie Street and Compton street, the site is currently undergoing massive changes. Designated as a Corridor zone within the Halifax Centre Plan, it is in the process of being developed with a contentious design under construction at the time of writing.



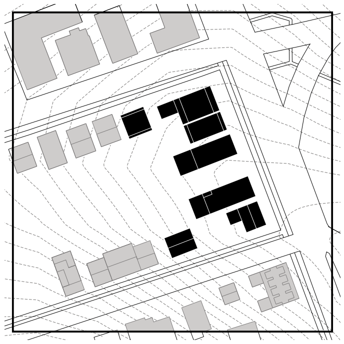
Design Site.

## The Halifax Centre Plan

The Centre Plan is a set of planning documents for Halifax Regional Centre, which includes Peninsula Halifax and parts of Dartmouth inside the Circumferential Highway. It is

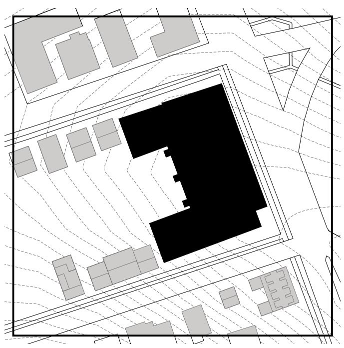


Halifax Peninsula, Nova Scotia, design site at centre.



Pre-Existing Buildings Figure Ground.

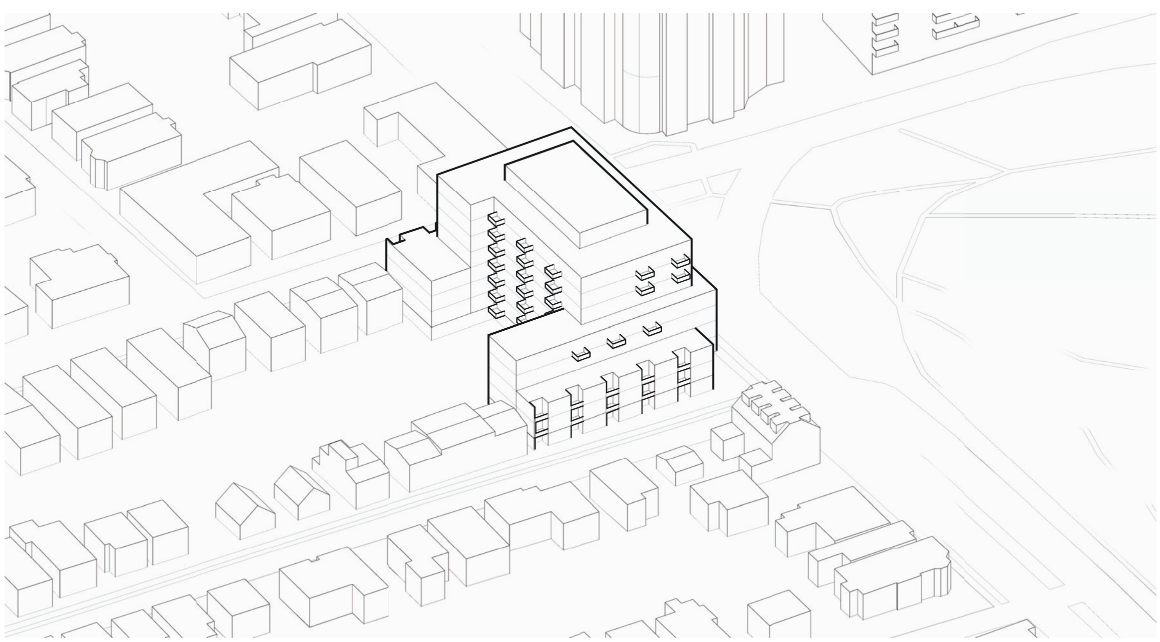
stated that the Centre Plan is “based on the core concepts of complete communities, pedestrians first, human-scaled design, and strategic growth in areas served by transit and other services”, in addition to creating mid-rise density and integrating newly designed development into the existing architectural characteristics of the context. The resulting developments, however, have not been achieving these goals, with the in-progress building at 2170 Robie being a prime example.



Proposed Building Figure Ground.

## Proposed Development

The in-construction housing at 2170 Robie has been a contentious project since its inception. According to an article by local newspaper The Star, “The proposal doesn’t fit the current rules for the area, but staff told council it generally aligns with the coming Centre Plan”. Neighbours



Axonometric of the design for 2170 Robie proposed by WM Fares Architects.

have voiced a variety of complaints and concerns: they specifically want the streetwalls lowered on Cunard St. and Compton Ave (Walton 2019). Other concerns include the height of the building being imposing on its neighbors, creating a feeling of observation in their backyards, as well as an increase in traffic along Compton Ave making it less safe for children and a lack of affordable housing options in the development. Residents feel that the developers are asking the citizens to make many concessions regarding quality of life and making none themselves, with the development giving nothing back to the community via affordable housing (McKenna 2019). The VP of planning and design at WM Fares, Cesar Saleh, says that issues such as street calming

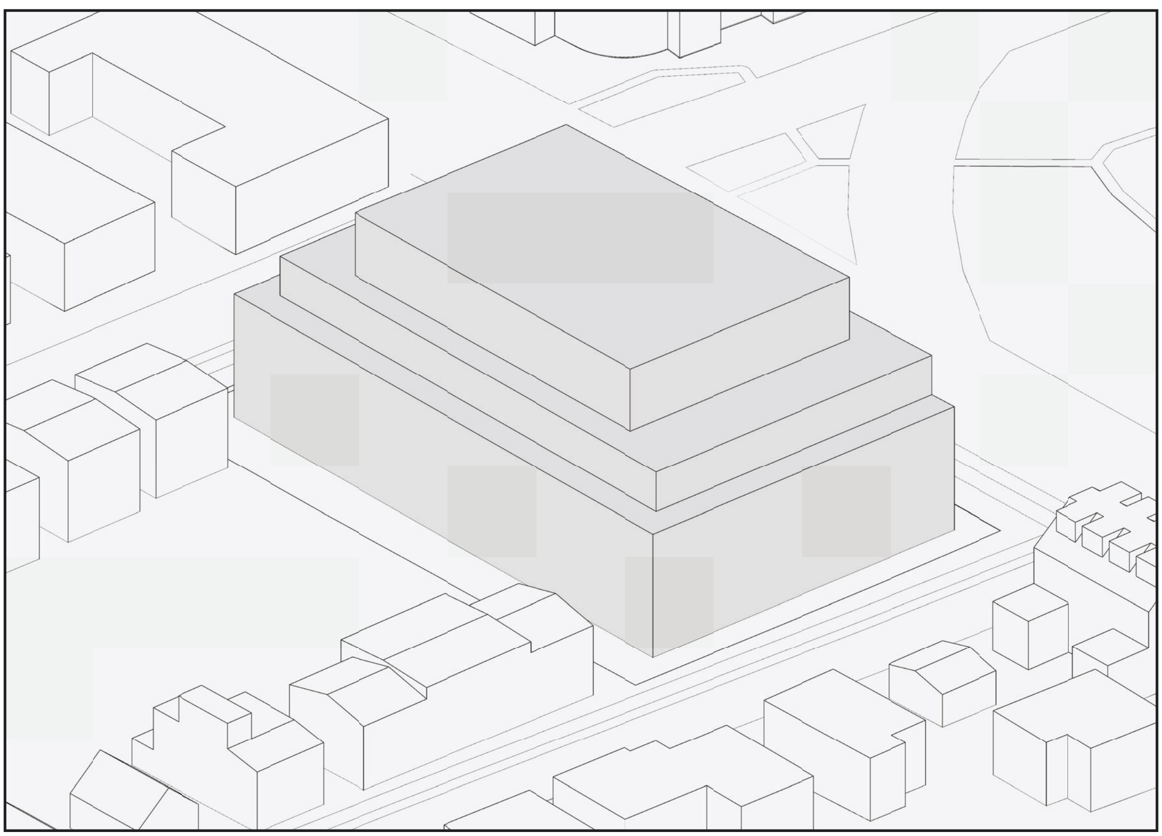
West-facing view of 2170 Robie, from the Halifax Commons.

Construction Site at 2170 Robie.

are beyond the scope of their work, but that “they’ve done lots of work to give back to the community by creating jobs and places people can live.“

## Centre Plan Volume

The Halifax Centre Plan lays out specific requirements for the dimensions of a building in relation to the site. These rules are parametric in nature: ground floor at 3.5m, maximum height at 3-6m, streetwall stepback at 2.5m, minimum 1m yard, 6m when adjacent to a residential property to name a few of the larger scale requirements. These dimensions create a volume that is geometrically pre-rationalized by the planning documents. In order to get the most units from the site that they own, developers then treat these dimensions



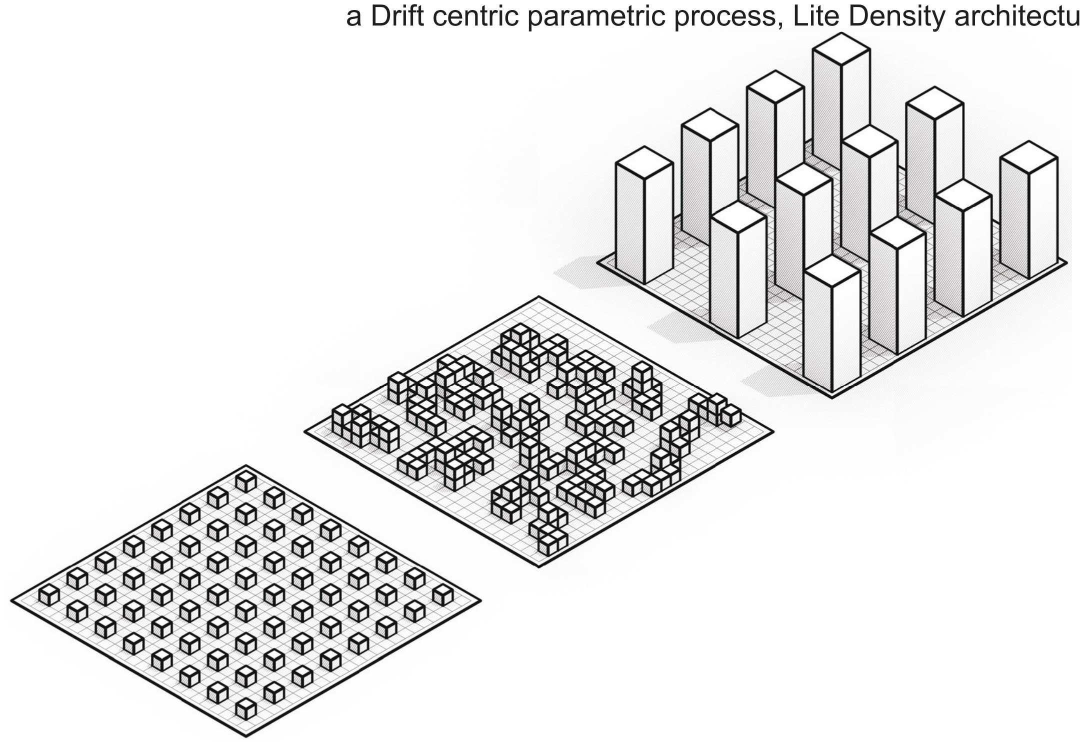
The volume generated by the constraints of the Halifax Centre Plan site requirements.

as the absolute limit of the design, and the resulting building is sculpted by the planning documents as the designers attempt to get the most density from the site.

## Alternative Forms of Density

### *Lite Density*

From Kowloon City to the sprawling suburbs that extend out from many major cities in North America, there is great variation within housing density. The form of density is vital when designing urban housing, and investigation into density can suggest architectural alternatives to the blocky development present in rapidly growing cities such as Halifax. A type of urban density that could work well with the Centre Plan's requirements for Corridor designated sites is what Winy Mas calls "Lite Density". The intention of Lite Density is to create a middle ground between massive tower development and spread out suburbs. When combined with a Drift centric parametric process, Lite Density architectural

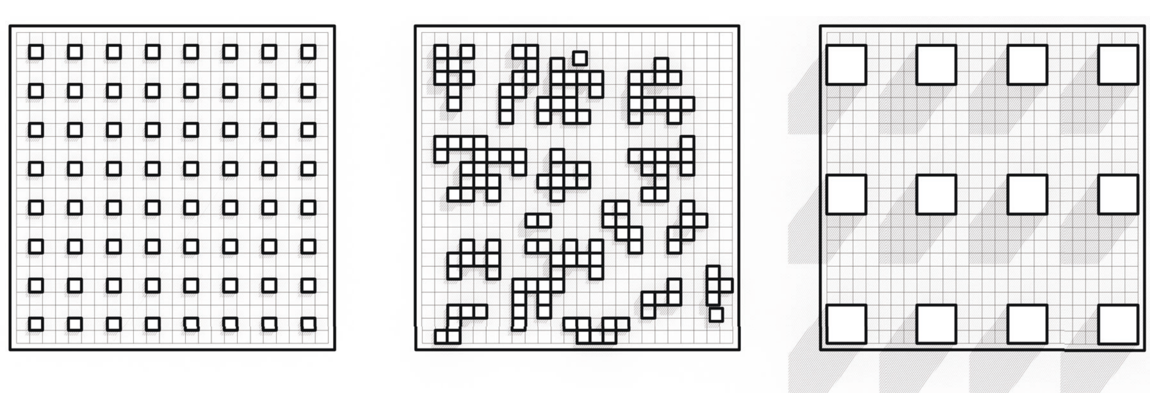


Finding a middle ground: Lite Density compared to urban sprawl and massive tower developments.

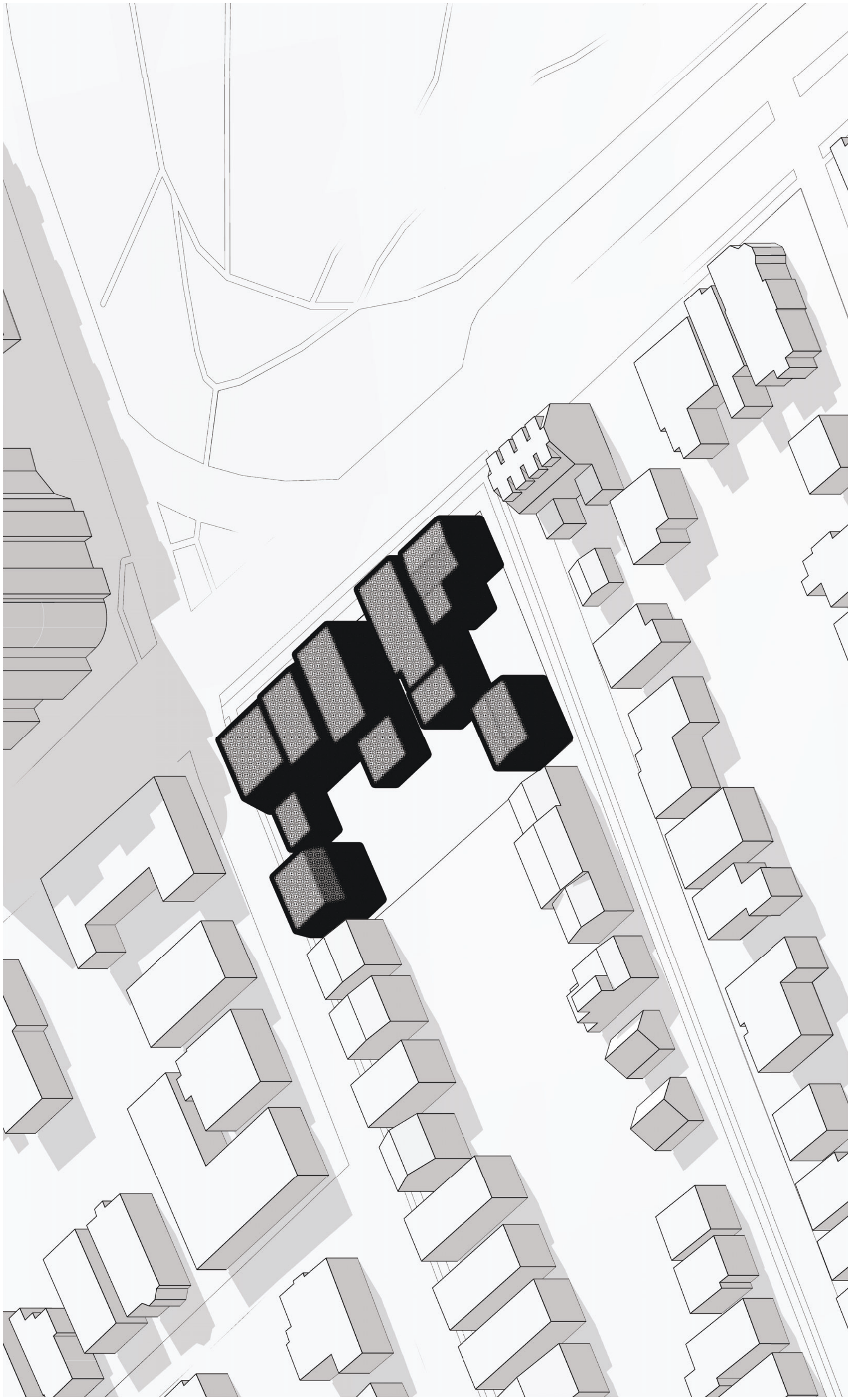
form also results in a more complex urban space at the pedestrian scale (Mass, van Rijs, and MVRDV 1998).

### *Soft Urban Space*

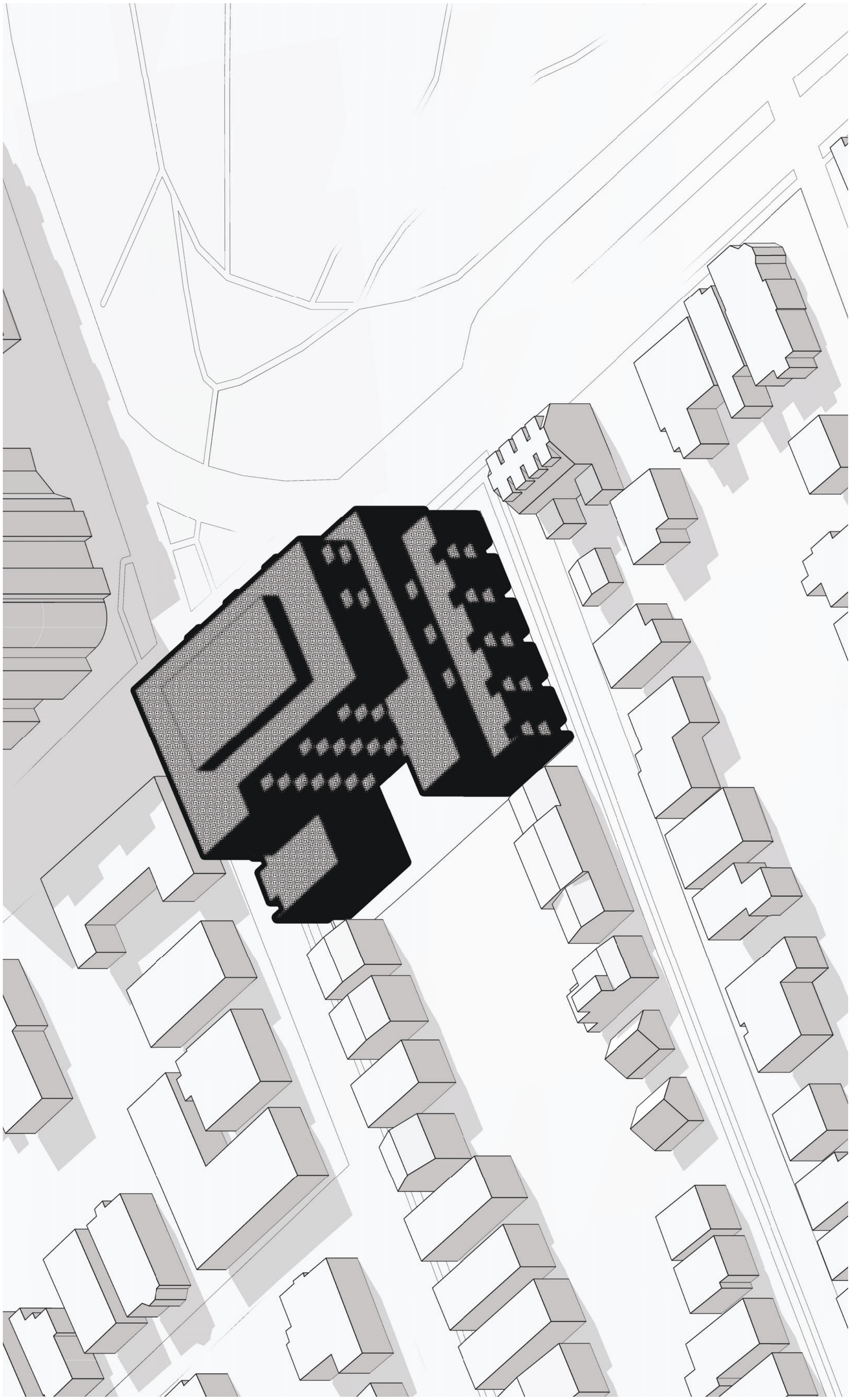
The combination of Drift focused parametric process and Lite Density allows for a greater diversity of space at the scale of the individual by loosening the grip of geometric pre-rationalization on the resulting architecture. By breaking the volume of the site as generated by the planning documents into smaller component units, the building becomes an ecosystem grown through the logic of spatial connection rules. Viewed in plan, the greater diversity of form also increases street edge along the outside of each building, a characteristic which creates more intimate human scale urban space while maintaining the density required for growing cities (Sim 2019).



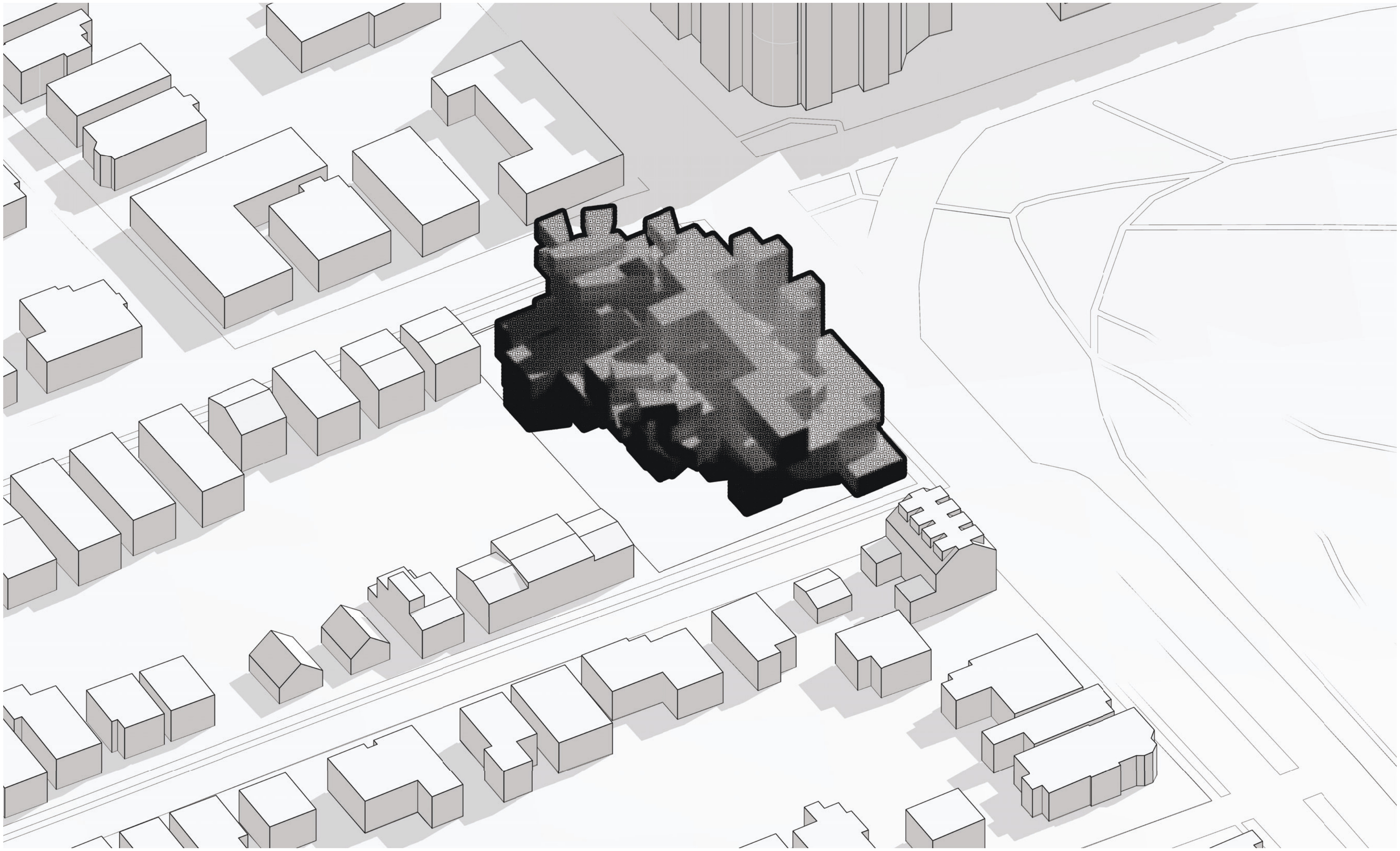
Center: the increase in streetwall length that can result from the combination of diverse urban space and Lite Density.



Historic massing volumes (1945 - 2022)



Current development (under construction)



Drift process parametric housing.

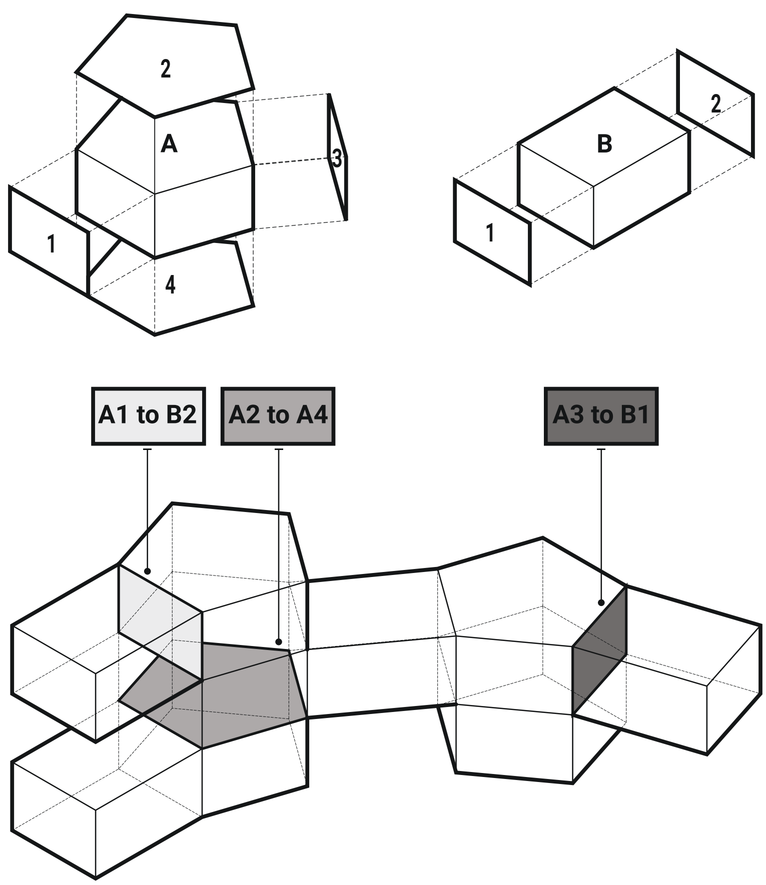
# Chapter 7: Digital Tool Review

## Rhino 3D and Grasshopper

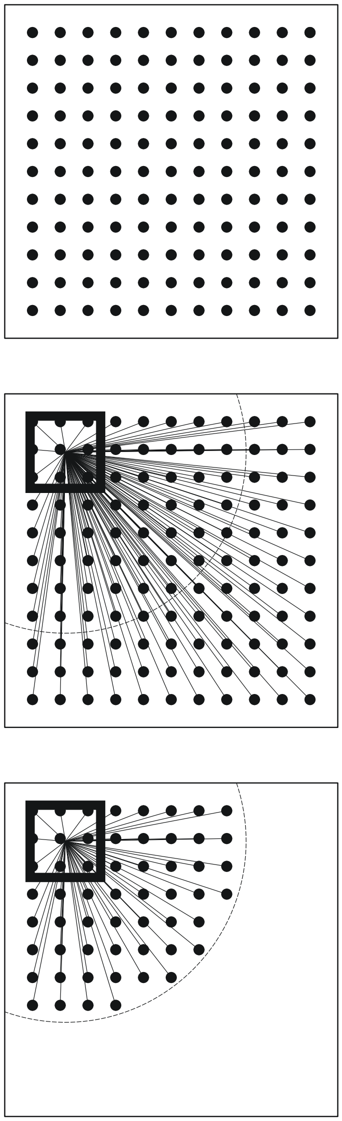
The primary modeling tool used for the design work was Rhinoceros. Generally abbreviated to Rhino 3D or just Rhino, Rhinoceros is a free-form surface modeling program developed by Robert McNeel & Associates. An advanced software known for its ability to utilize NURBS (Non-Uniform Rational Basis Splines), SubDivision geometry, and point clouds, the most important feature that Rhino has in relation to this thesis is the integration of a program called Grasshopper. Grasshopper is a visual programming tool that is built into Rhino 3D. It allows designers to utilize the power of parametric design without any prior knowledge of programming, and it is the primary tool that the majority of parametric architects use at the time of writing. It is a very intuitive piece of software with an add-on library that is full of (mostly) free tools, such as Wasp, the primary software used for this thesis.

## Wasp

Developed by Andrea Rossi, Wasp is an open-source, free plugin for Grasshopper. Wasp is primarily a tool for the creation of aggregations from discrete elements, or parts. Primarily in this thesis Wasp was used to create stochastic (or randomized) aggregations between parts. The parts were at the scale of a small to medium sized room, with the intention of the result being human scale diversity of space (which is to say uniquely arranged spaces at a size that is easily inhabitable by individuals). The image below describes the basic functionality of Wasp: connection points on faces of geometries are given numbers, and then rules are written that establish a relationship between those connection points. Wasp then “grows” the aggregation using those written rules. Once these rules are established, the user can increase control over the aggregation in a number of ways. The secondary control method used in the design work was Field Aggregations. This is also accomplished through the use of Wasp. The user creates a volume and fills it with a grid of points. Next, they establish a piece of geometry, and the software measures the distance from that geometry to each point. Once this is done, the aggregation can be controlled by making it more likely that parts will be placed close to the geometry, or the opposite. This allows for the clustering of parts controlled by the user.

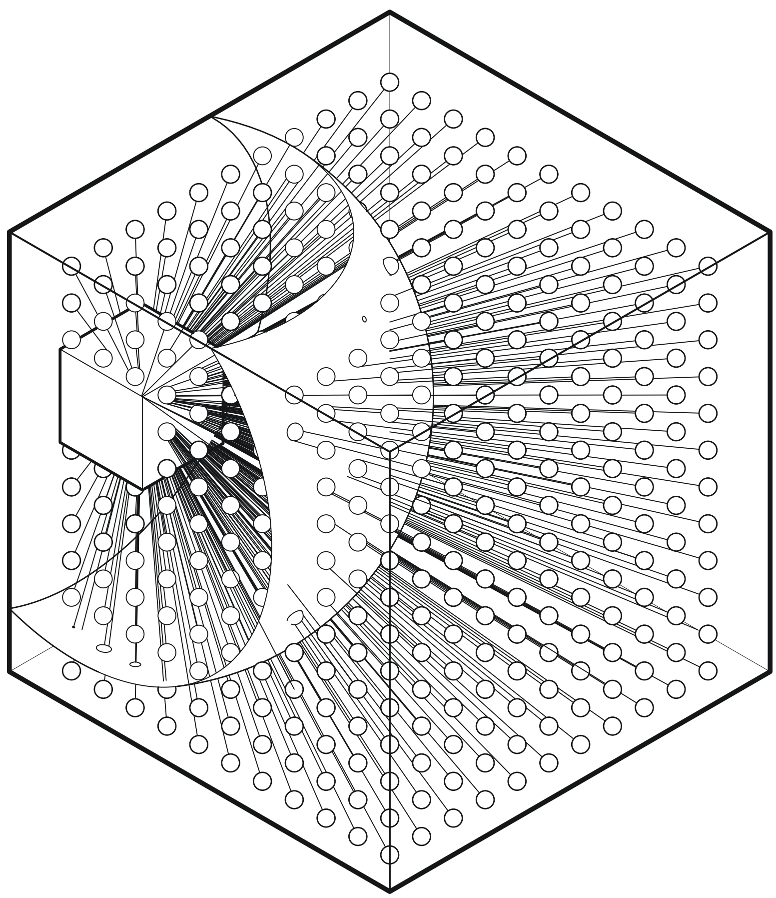



The creation of aggregations using Wasp to establish geometry and connections.



## Node Based Programming

Node based form programs like Grasshopper are an interesting typology digital form generation tool. While at first glance it might seem like a more impersonal way of designing than the scale-less world of a 3D modeling program, node-based design can be a method of design that is much more intentional and sensitive than a 3D software like SketchUp or Revit. As we know, a requirement of parametric process is input. Inputs are then manipulated, and then processed into an output.



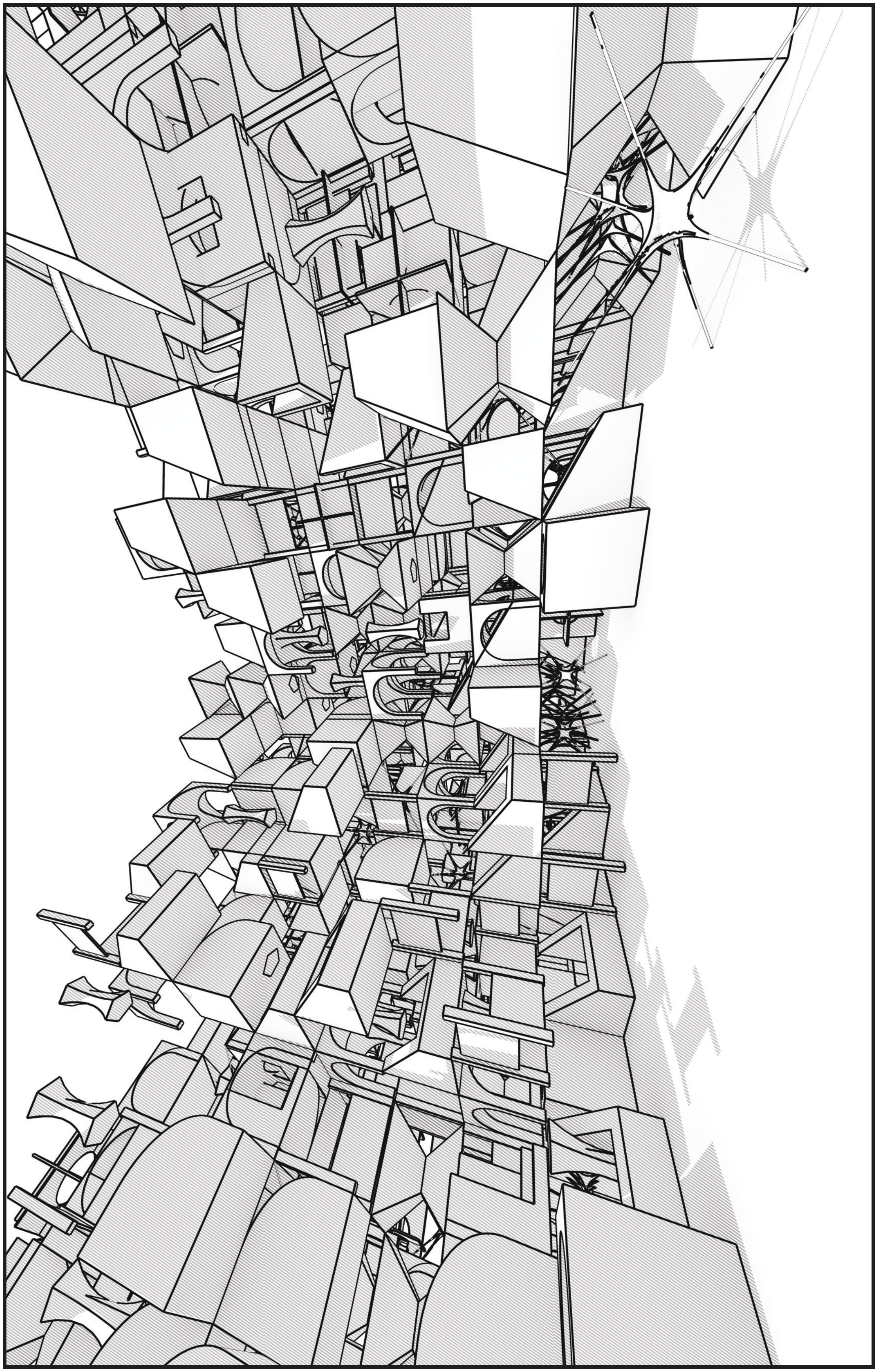
Field Aggregations using Wasp: Creating a field of points, measuring distance from geometry to said points, and making it more likely that a piece is placed close to the geometry.

## Drawing with Parametric Tools

For example, to create a non-parametric doubly curved line in Rhino 3D one could select the “Spline” tool, and then click in the environment for a starting point, 2 middle points to create the curve, and an end point. This creates a curve. Creation of a similar line in Grasshopper still requires those same 4 points, but the form of control available to the designer is different: instead of clicking a spot in the environment to create a point, the designer can construct a point using a set of coordinates. They can then control the location of each point and see the changes to the line in real time. They can also alter the fillet radius of the curve between the points. It may seem more impersonal at first, another level or dimension removed, but the ability to iterate so quickly and accurately opens the door to emergent form and ideas. It is more akin to taking a piece of paper and bending it in one’s hands than clicking in the 3D environment of a modeling software.

### *Formal Intention*

The biggest difference between parametric work and traditional 3D modeling comes before any design move is made. The node-based ecosystem requires a holistic understanding of the formal intention behind the design, which could be why geometric rationalization is common in the world of parametric architecture: with so many possibilities at one’s fingertips, it  feels necessary to limit the form of the design to a simplified metaphor in order to remain in control of the design and not get lost in the labyrinth of complex geometry possible through parametric process.

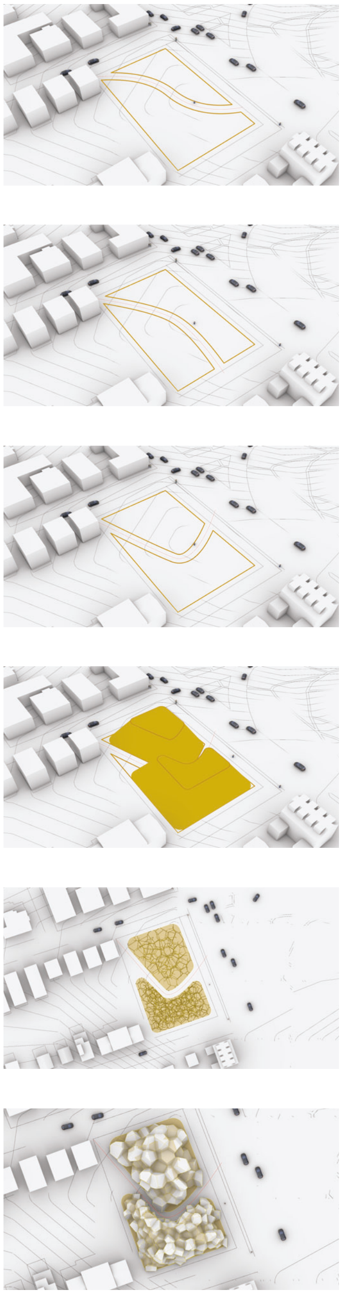


Lost in the labyrinth of parametric complexity.

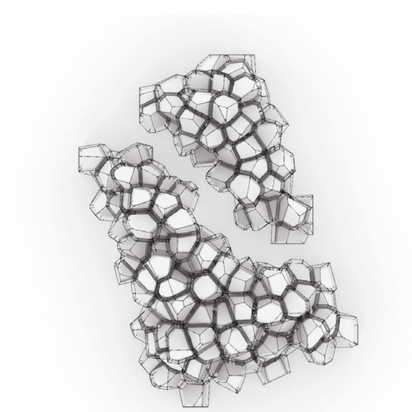
# Chapter 8: Drift Focused Design Process

## Blurring Parameters

Early in the design process, a series of toolkit testing experiments were run. Within the parameters available to native Grasshopper (no extra plugins installed), an attempt was made to blur the control that certain parameters had over the result through Drift. This was acheived by creating several levels of translation, points at which Drift could occur: The creation of a simple volume on the site, a population of points within said volume, a randomized geometry set with its center at each point, and then a script that removed any geometry which had its center outside of the volume. The result was a compelling first step in the direction of a parametric Drift design process: one could manipulate the site volume and number of points, resulting in entirely different massings but without having direct control over certain characteristics. A helpful test, but the result was simultaneously not controlled and not as randomized enough for the results to be more than a geometric massing: it was a whole split into parts as opposed to a whole grown



Form from Shape: Using a parametric site subdivision to create a volume, populate it, and then roughly sculpt the units by blurring the form: the cells are filtered by their center points, not where they intersect with the volume, creating Drift as control is lost and the shape leaves the perfection behind.

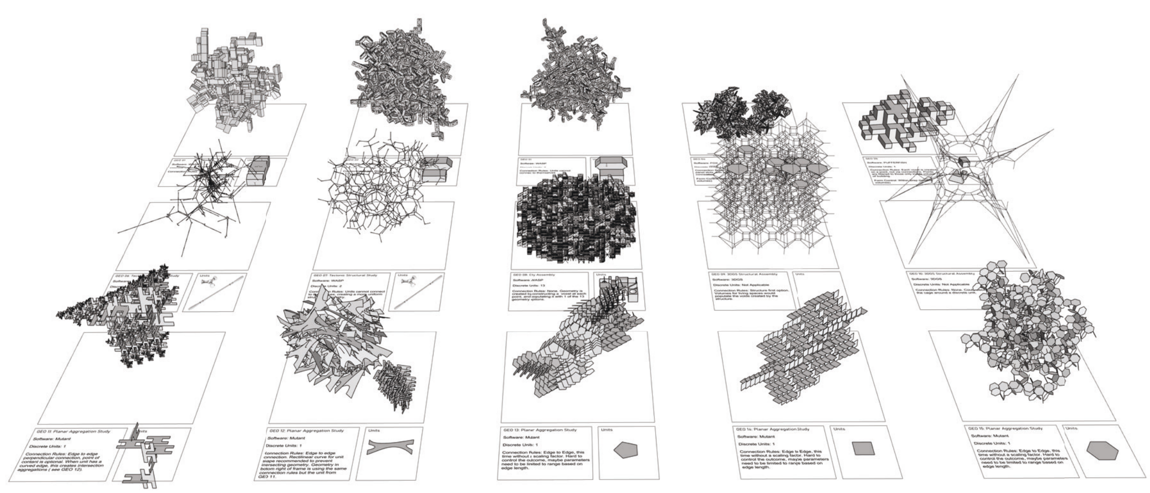


First steps: the result of a parametric massing generator script.

from a series of parts, a process called a stochastic (or randomized) aggregation.

## Geometry Tasting Menu

Within the workflow of Rhino and Grasshopper, there are many plugins available created by programmers and designers and made available for free. As the freedom and limitation afforded to the user by the tool can be a major determining factor in the resulting design, an important step in the process is determining the right tool to use. By creating a tasting menu of sorts from as many different plugins available that create stochastic aggregations, comparisons were made to determine a software that would be able to work with the balance of control and Drift that the thesis investigated. The result as previously mentioned was a plugin called Wasp, which was chosen for its many levels and scales of control. The user can manipulate connections at the small scale, or through a distance from a geometry, to name a few. The result of these many different angles to go at a problem are one of many spaces that Drift enters

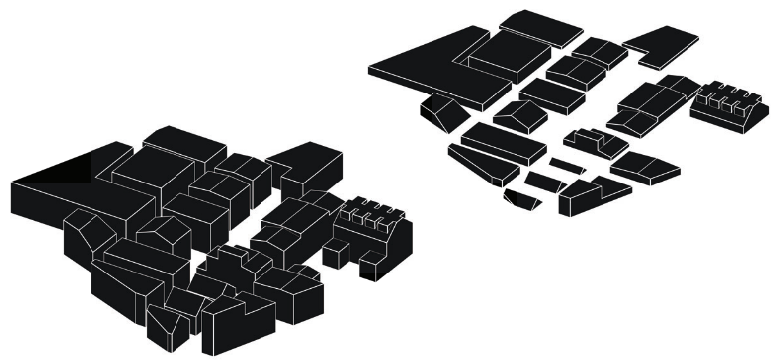


A tasting menu: in order to determine an appropriate tool for the project, a series of explorations using different Grasshopper plugins were run.

the design process, through the translation of methods of control to the resulting design.

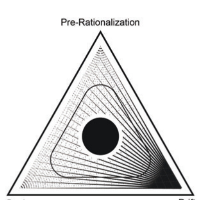
### Hand-Made Aggregation

Early in the design process, when investigating the correct tools, there was work being done on physical models. As the main catalyst for Drift is the translation from digital to physical, it was clear that physical models were necessary. In the process of 3D printing context buildings, there was an error that caused only the top quarter of each building to be printed. After printing the full buildings, it was clear that the scale was not going to show enough of the context.

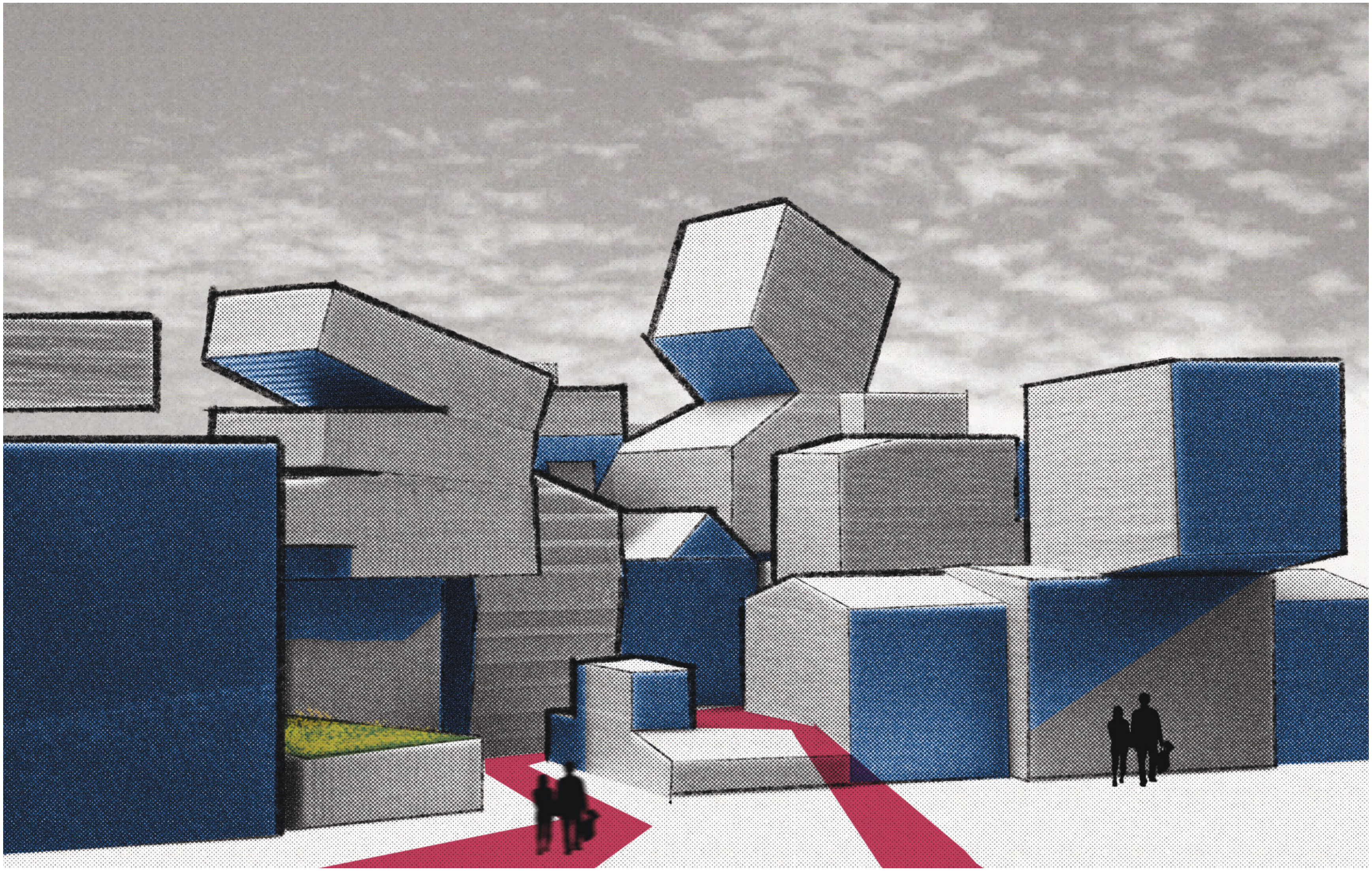


Model showing the 3D printed pieces that would become the aggregated urban space sketch model.

Urban space sketch model.




Example of Drift Compass usage.

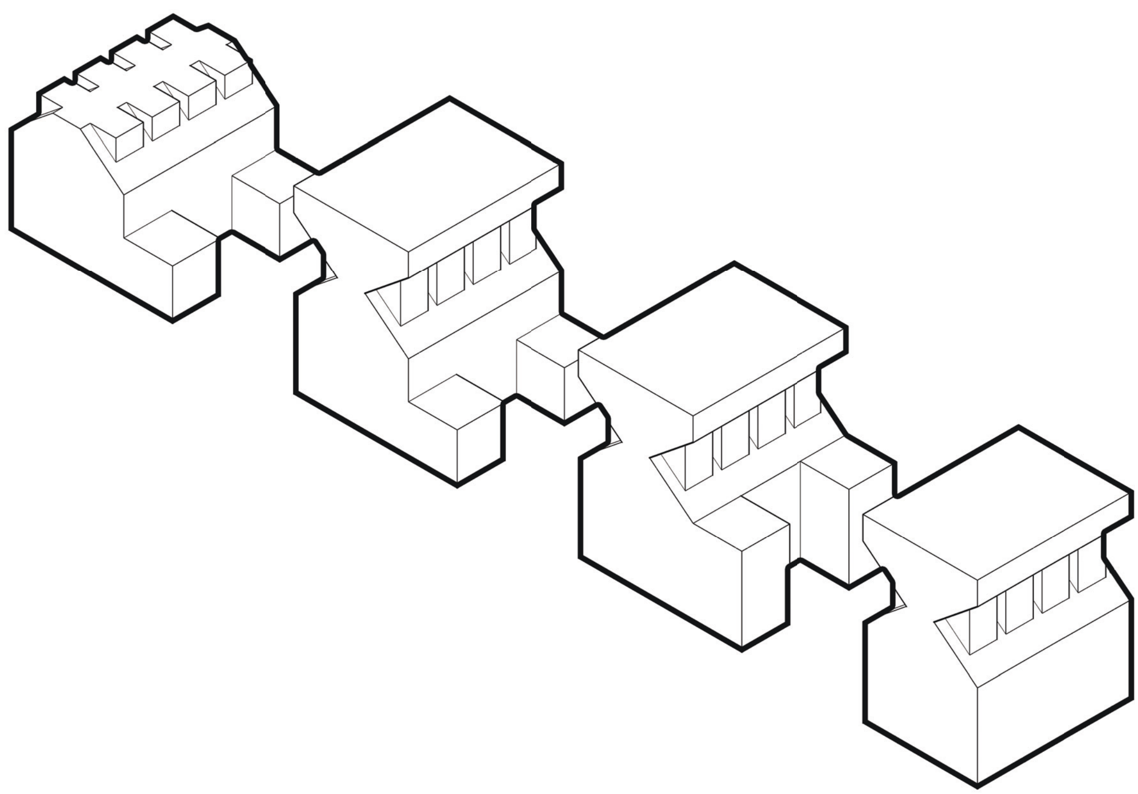


Inhabited Vignette of the urban space sketch model.

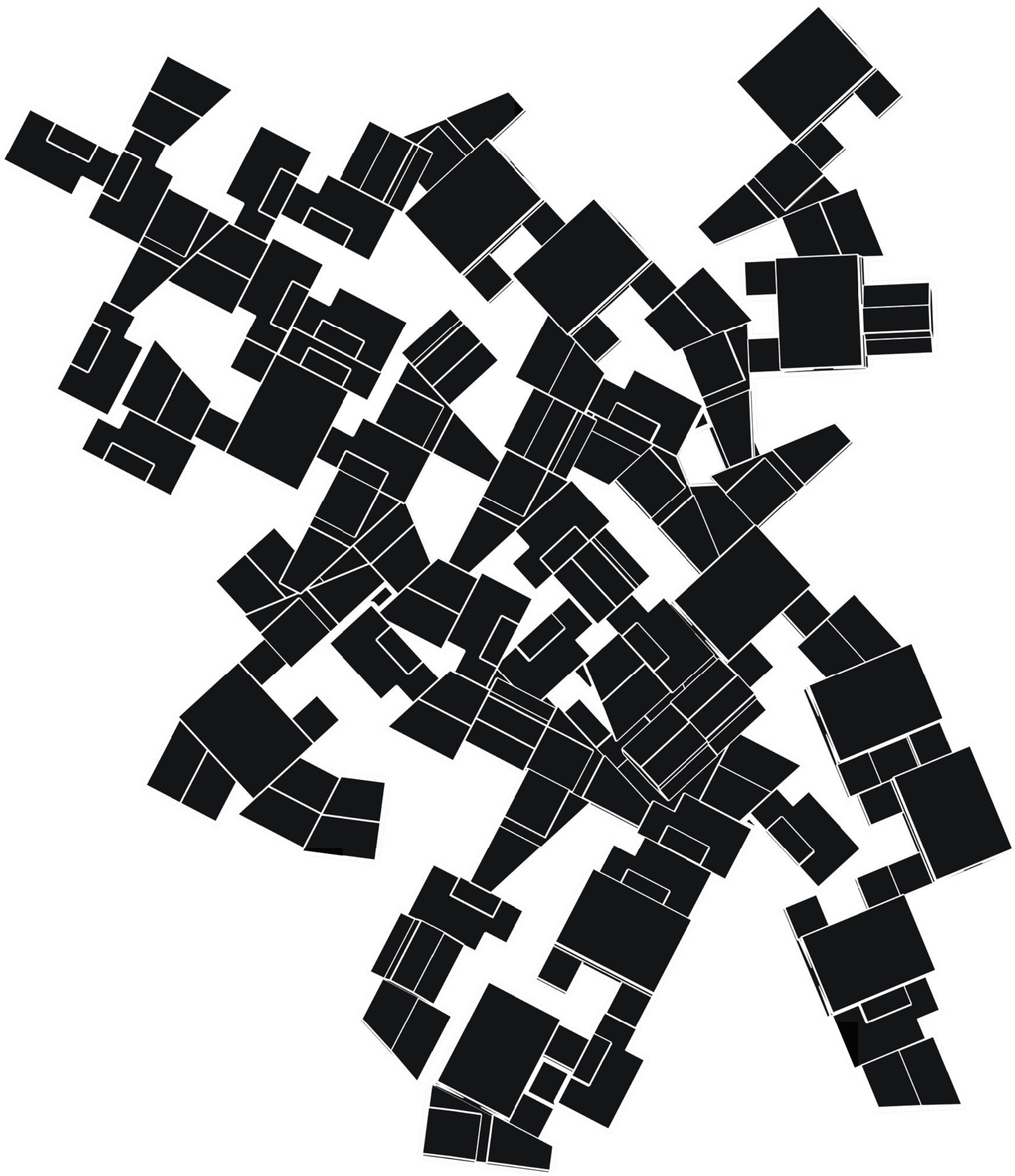
As an investigation into the potential of randomized urban space, the two batches of 3D printed pieces were combined into a sketch model. The result is a study in complex urban space, one that reveals through inhabitation collage that a key part of complex city spaces is articulation at the scale of the person and room.

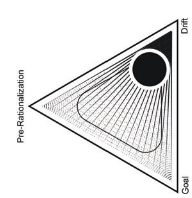
## Parametric Ruin Figure Ground

The completion of the sketch model and the resulting decision was that the primary factor of concern for the resulting aggregation was the articulation at the scale of the human oriented space. With this in mind, several of the most compelling composite volumes were selected from the sketch model, and used to create a series of aggregations using Wasp. The initial assemblies modeled were the result of Wasp Component connections only on vertical sides of



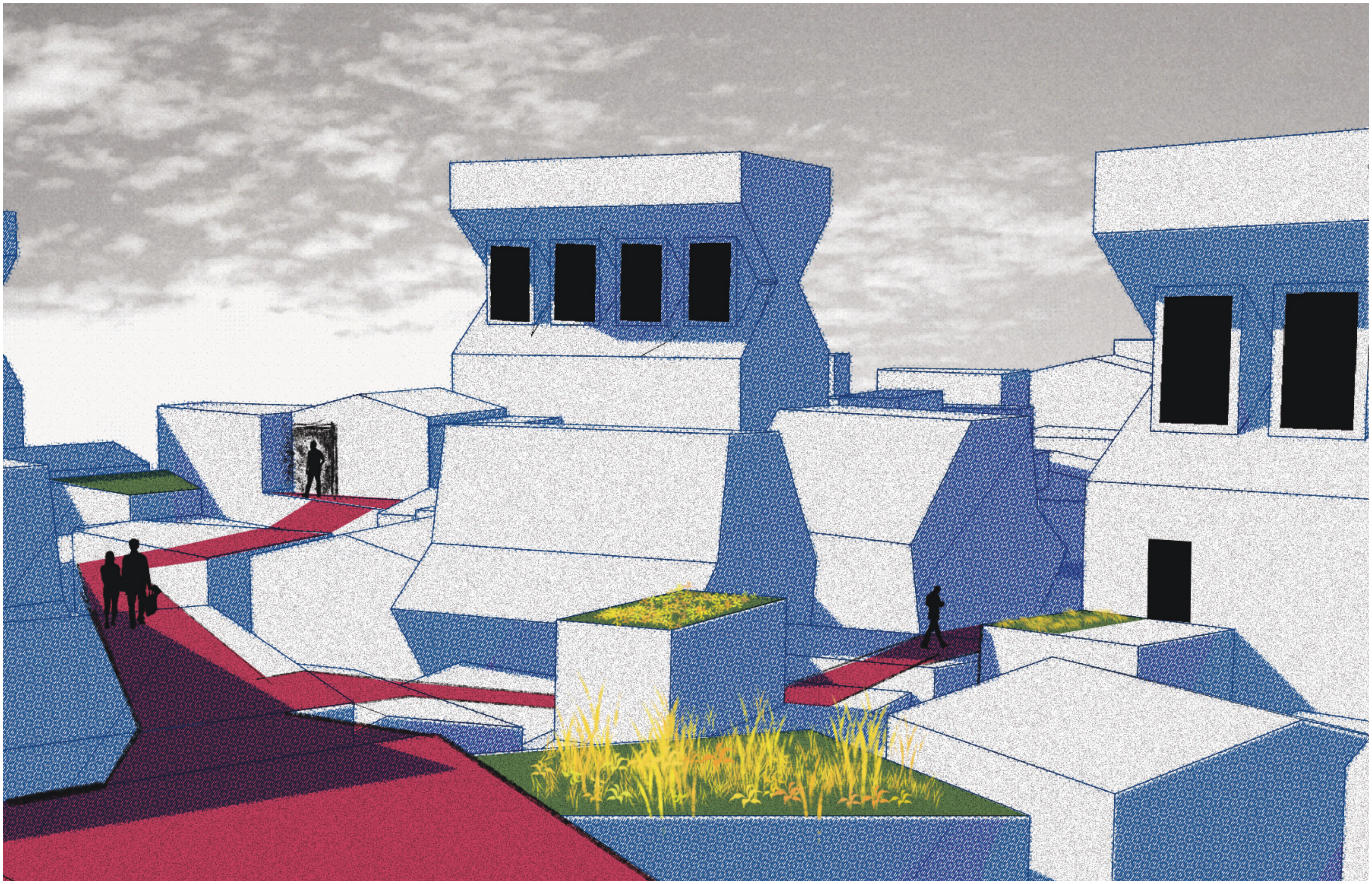
Creation of composite volume for Wasp Aggregations (read left to right).






Stochastic Aggregation resembling an ancient city in plan.


3D printed model of the ancient city aggregation.

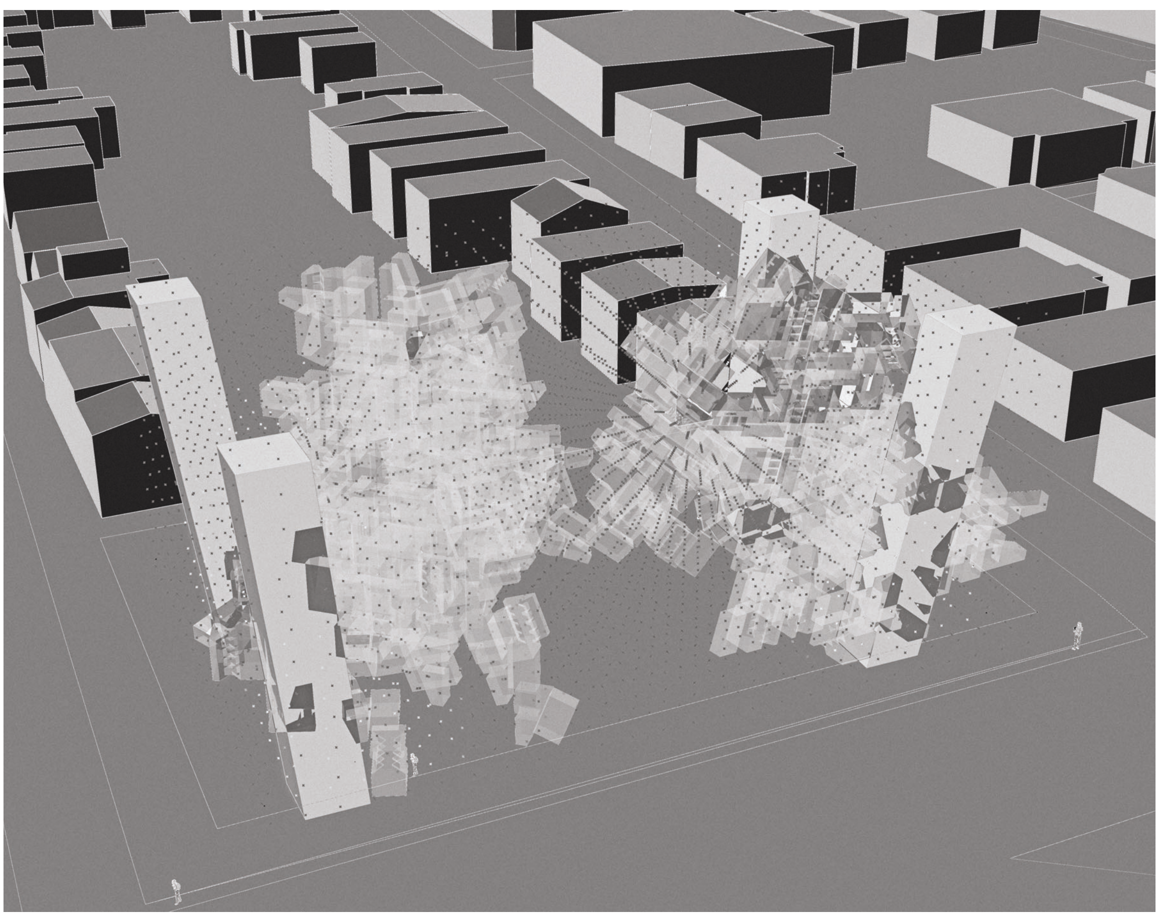


Inhabited Vignette of the ancient city aggregation.

the pieces, and resulted in aggregations that when viewed in plan could resemble the figure ground of an ancient city. This resulting aggregation was a move in the right direction vis-a-vis complexity of urban space, but the density required for this project was not yet present.

### Clustering Aggregations

With the intention of creating a densified housing design, the next step in the process was the clustering of units around organizational geometry, in this case cores for elevators and services. Taking inspiration from Habitat 67 with its external cores and circulation, tests were completed on how the aggregations would react to the added parameter of a cluster geometry. Another added control method was Wasp



Site scale core cluster test.

Inhabitation test of clustering aggregations around cores.

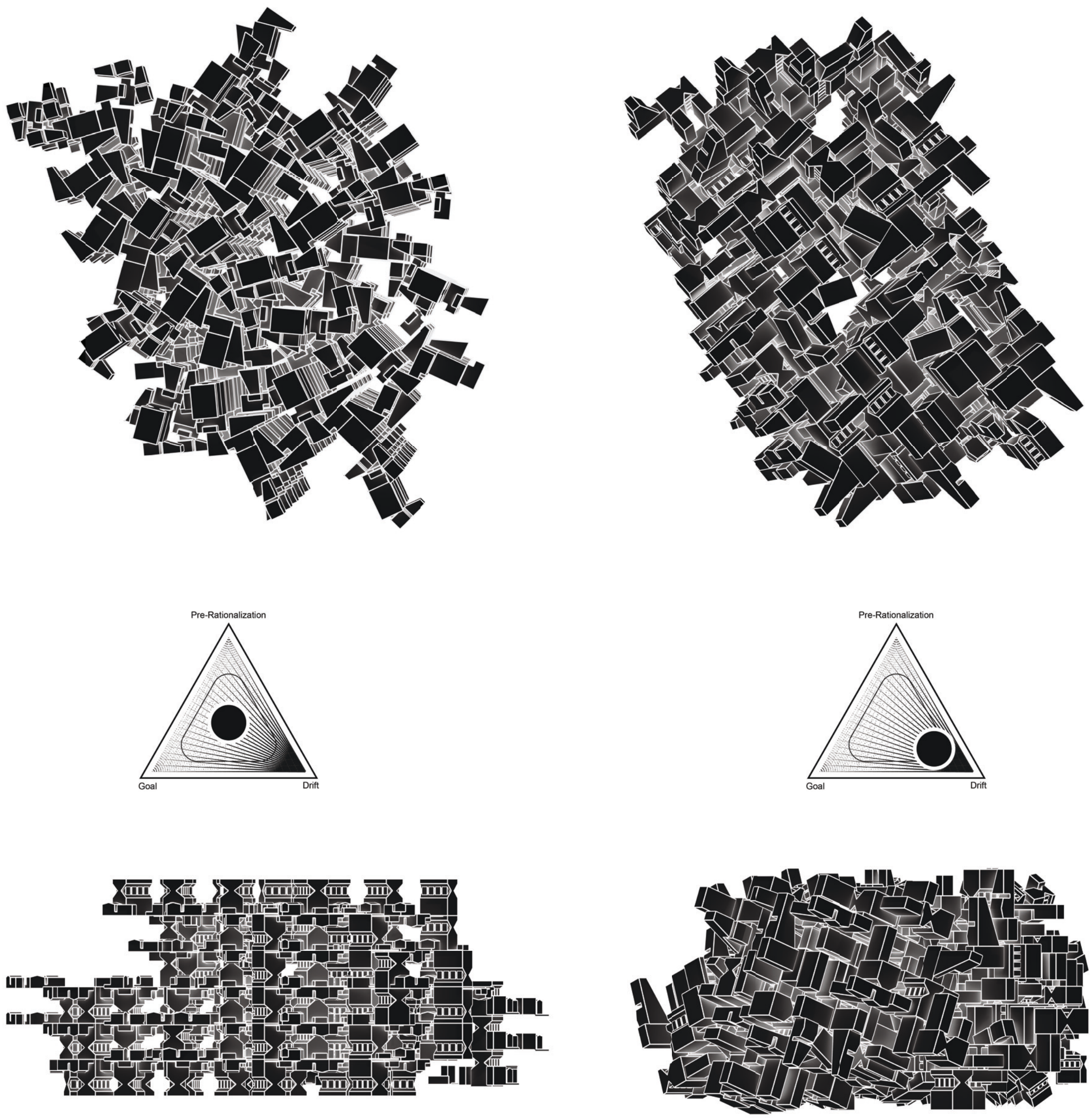
Connections on the tops and bottoms of the aggregated volumes, allowing the software to grow in all directions around the cores. Still far too randomized, however, these aggregations needed to be controlled in a way that would lead to them being recognizable as living spaces and therefore inhabitable. The Drift manifested as the software interprets how to place the pieces at a set distance from the geometry of the cores, but the balance of the result was too far in the direction of Drift.

### The Result of Rules

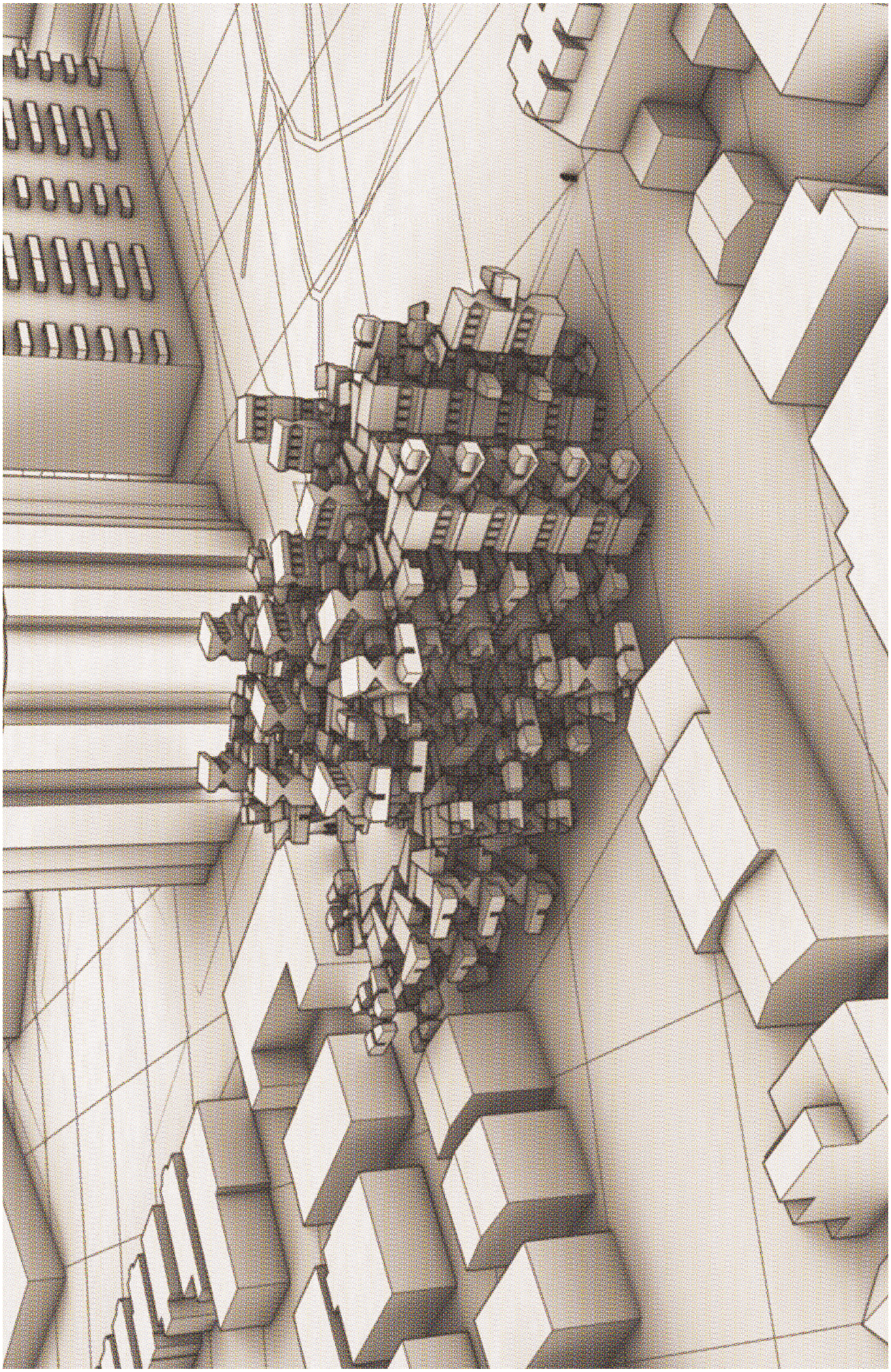
With the goal in mind of creating an inhabitable aggregation and balancing the Drift heavy aggregations back towards the architecturally usable, more control was added to the chain of parametric variables through written rules. Until this point, all connection rules had been randomly generated by Wasp. For these tests, each rule was hand written, and as the aggregations were generated the rules were added to or culled based on the result. An example of written rules:

0. [LIVING|0_LIVING|0]
1. [LIVING|0_LIVING|1]
2. [LIVING|0_LIVING|2]
3. [LIVING|0_LIVING|3]
4. [LIVING|0_LIVING|4]
5. [LIVING|0_LIVING|5]

Above are 5 of 255 rules written for an early aggregation version, where the name (in this case LIVING) refers to the unit type, and the number (3, for example) refers to the connection. So rule [LIVING|0_LIVING|3] means that connections numbered 0 and 3 on the LIVING unit can connect to one another. The resulting aggregations once the rules were added were much more controlled spatially, with the ability to decide and dictate how the unit pieces connected adding control but still allowing for Drift by creating a great diversity of rules. The resulting aggregations are both dense and complex, but the ones created with custom rules




Plan (top) and Elevation (bottom) views of aggregations created with rules (left) and no rules (right).

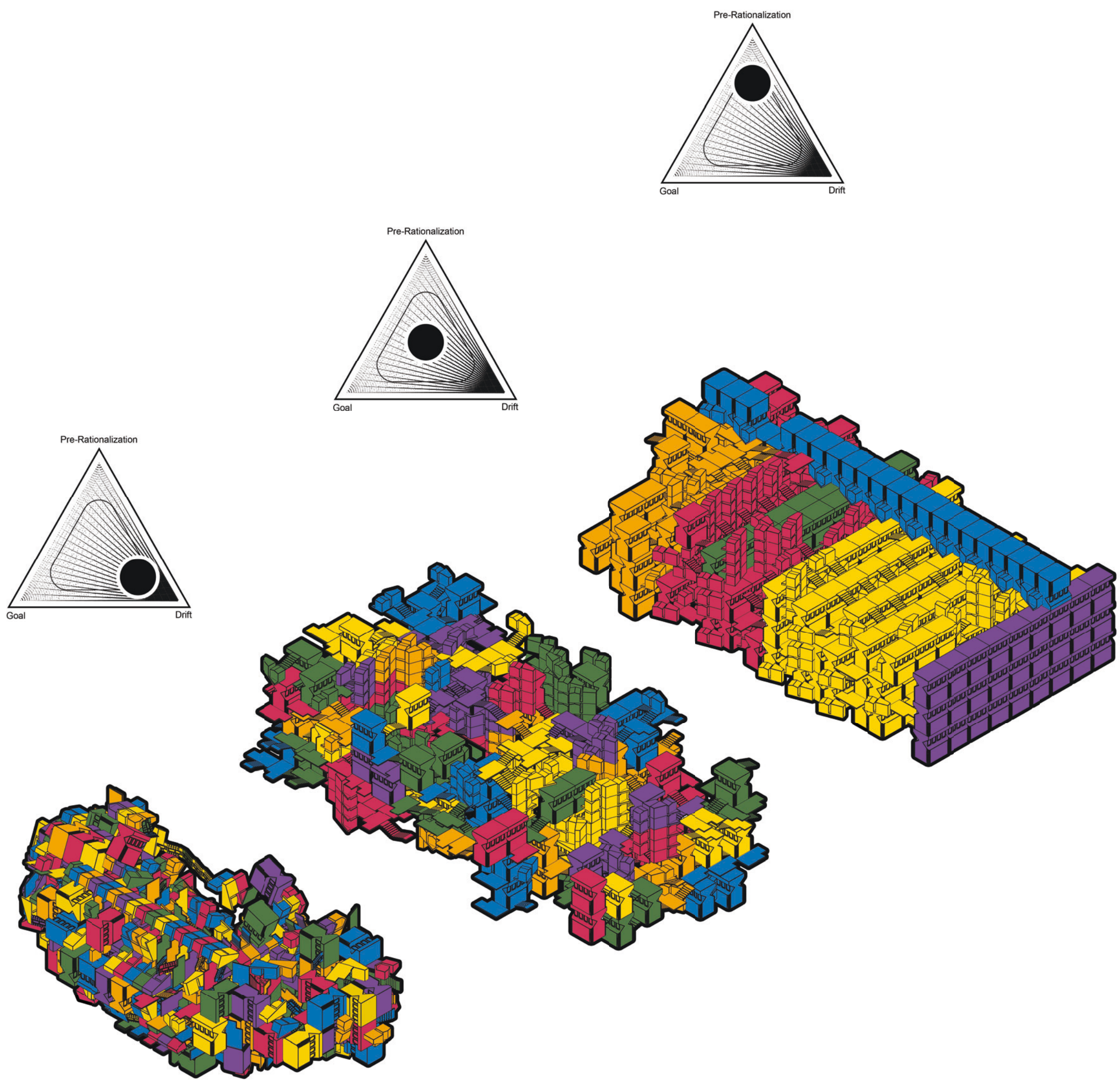


Custom Rule Aggregation: On site test.

have more order throughout, self-organizing into towers and clusters.

## Balancing Control and Drift

The result of these many investigations of aggregation control methods is a series of models that illustrate the relationship that is at the core of the thesis investigation: the relationship between control and Drift. What the images below show is that as control is gained over a process, Drift and imperfection are lost. Another way of saying that is that

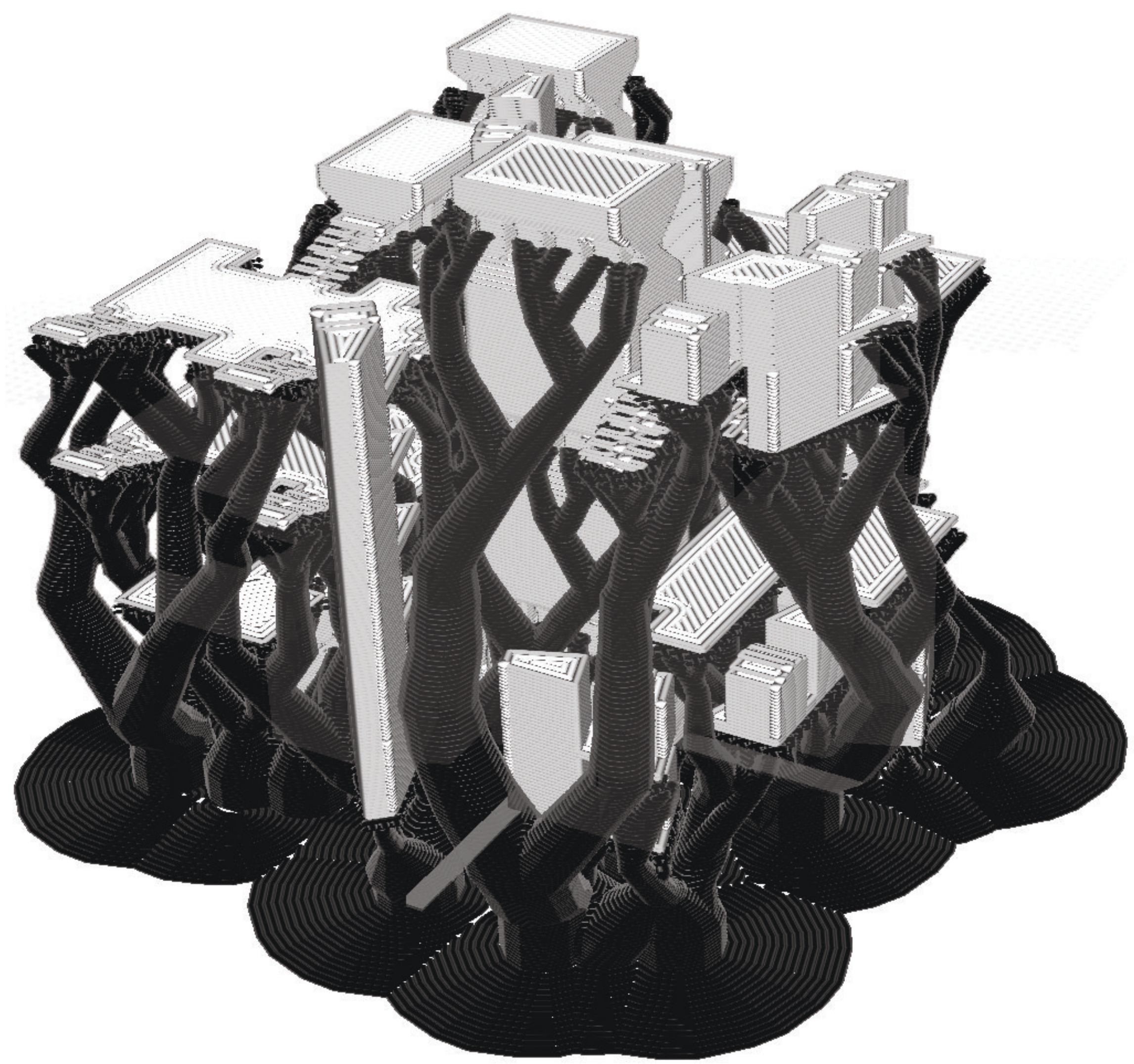



Left: no connection rules or limit on number of units. Right: connection rules and limit on units.
Middle: connection rules and no limit on number of units.

when a geometric pre-rationalization is used in parametric design, the process can be stagnated from the jump and not allow space for opportunity and chance to manifest.

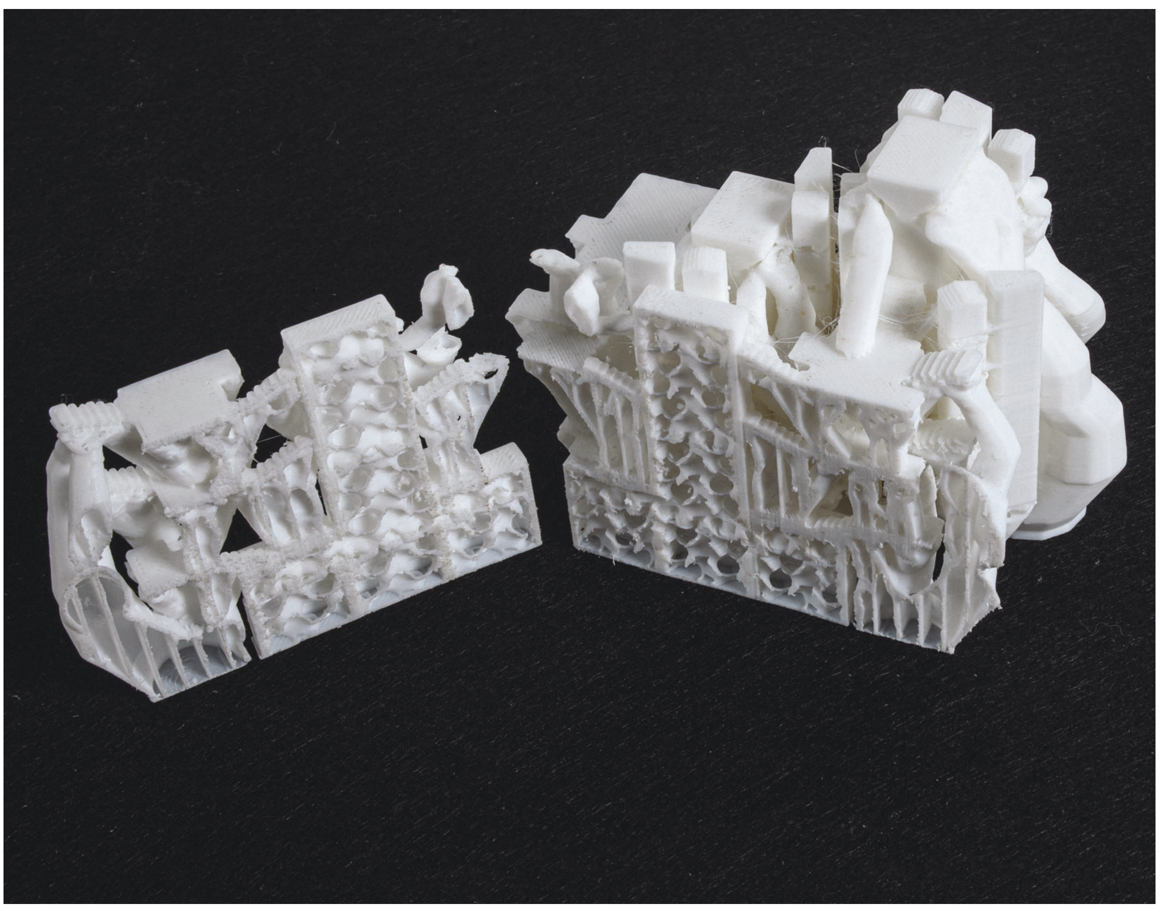
### Weaving Structure: Digital Production Test

In order to get a better sense of the created aggregation clusters, the first of several 3D printed models was created. This was also to stay focused on the method laid out by the thesis research: in order to discover how Drift can be productive to design, Drift must be present through translation (in this case from digital to physical). Once printed, it became clear that through a program and production



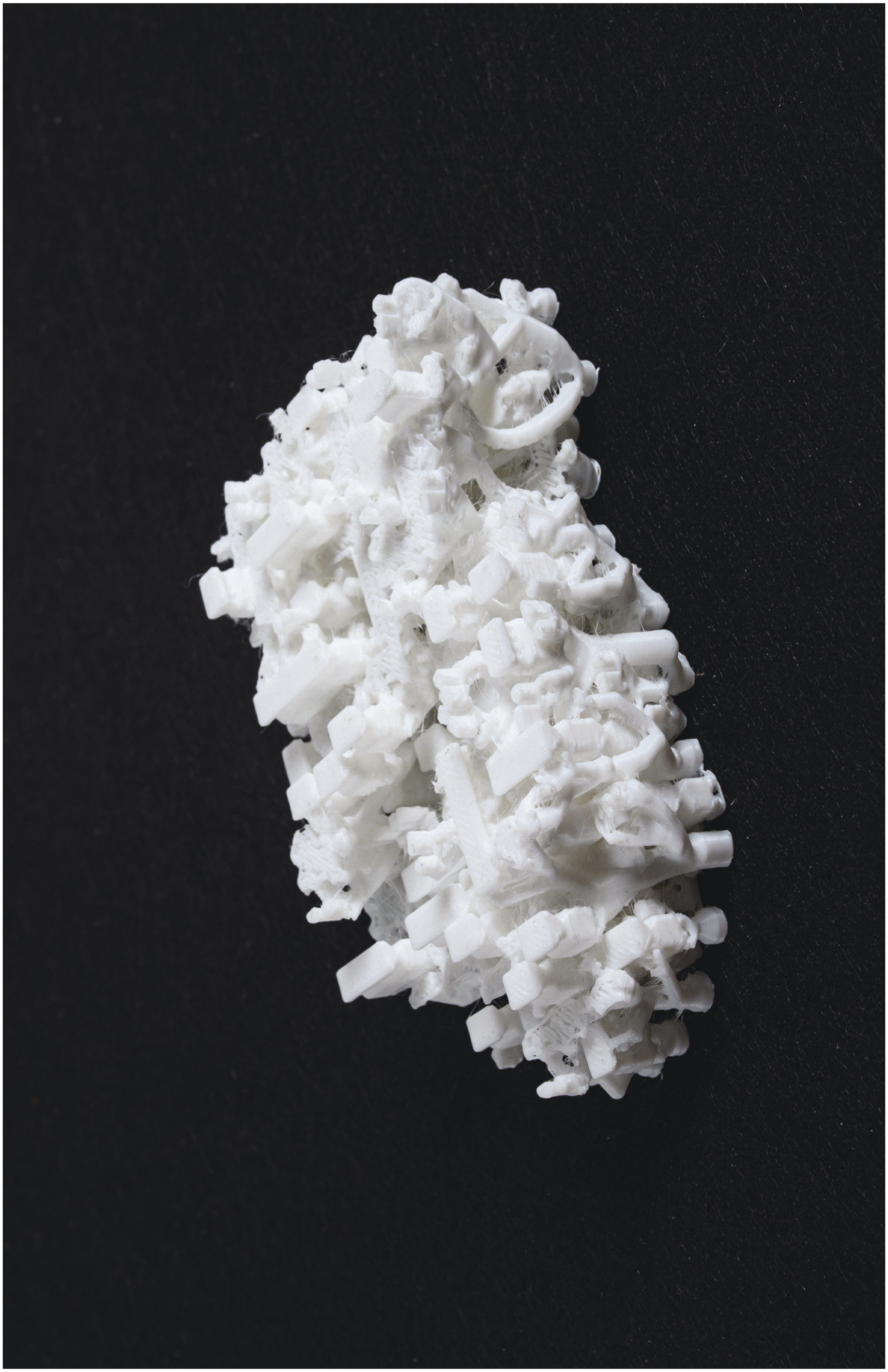
Model of aggregation cluster with generated supports prior to 3D printing.

error, the generated tree-like supports that were intended to keep the model upright while it printed were impossible to remove without breaking the entire object. The resulting 1:50 model then became a look at potential methods of weaving structure through an extremely complex building. The models that came from the first and second tests (the second being a site scale model) revealed that adding a parametrically generated superstructure to the aggregations filled out much of the space that was compelling about them, and resulted in an attitude towards density that was not far off of the geometrically pre-rationalized housing that was already under construction.



3D printed structure test model.

Testing models on site regardless of scale: investigating alternative building form with physical site models.



Site scale 3D printed aggregation with organic supports.

3D printed aggregation with organic supports site scale context relation test.

Further testing of alternative building form on site model.

All models created through process investigations.

## Circulation and Services

### *Circulation*

The results of the 3D print tests revealed that adding external structure to the housing aggregations would fill the volume of the site in a way that creates a quality of space that did not get enough sunlight for the climate of Nova Scotia, in addition to making the aggregation very difficult to navigate. The natural next step was working out a potential method of circulation throughout a highly geometrically complex building. By intersecting a plane with the aggregation at every floor height, and then offsetting that intersection by 3 meters, a winding external pedestrian walkway or street was created at every floor with space for inhabitation and life as well as moving through space.

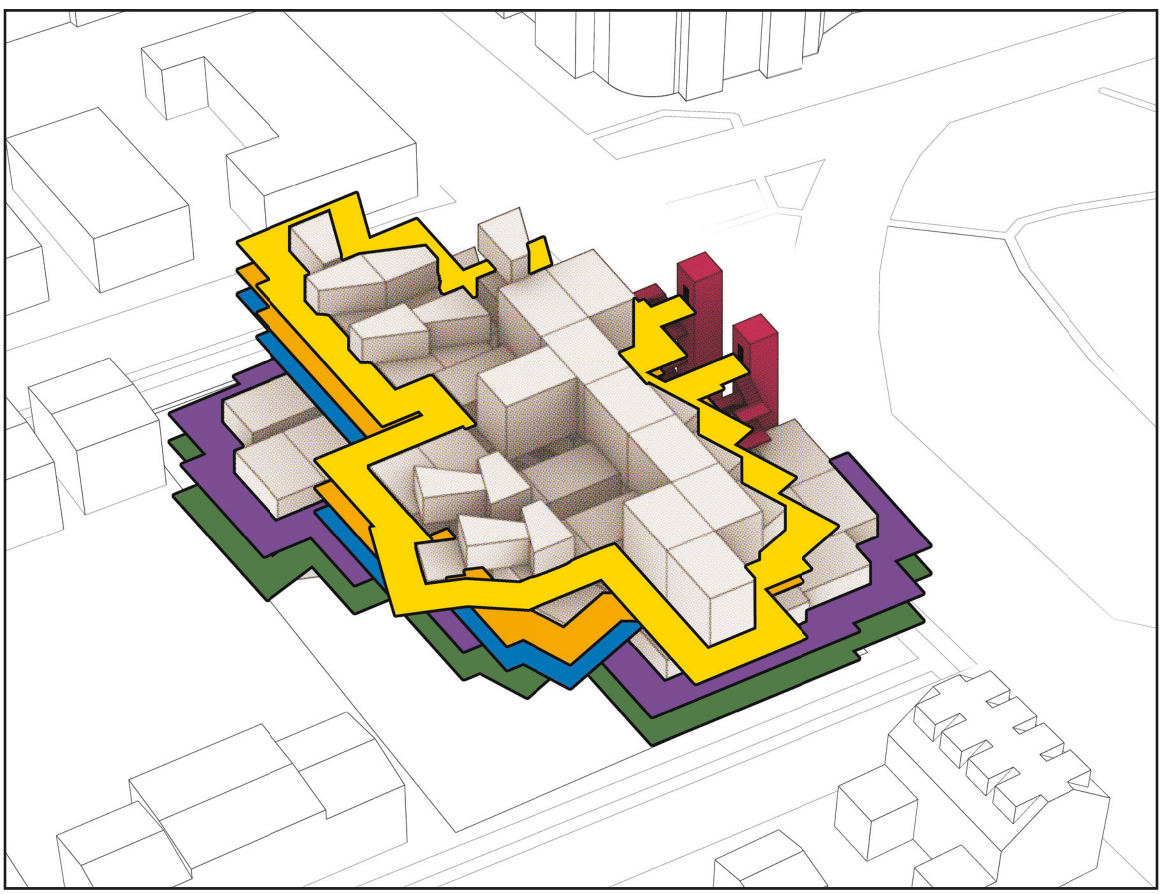


Diagram of a method to create circulation throughout stochastic aggregations.

***Services***

The placement of the circulation cores, circumnavigating the building, presented an opportunity. The services (heat, water, electricity) could be run through the structure of the circulatory platforms, enter the units through plenum spaces in the floor or the units, and through certain walls in each unit.

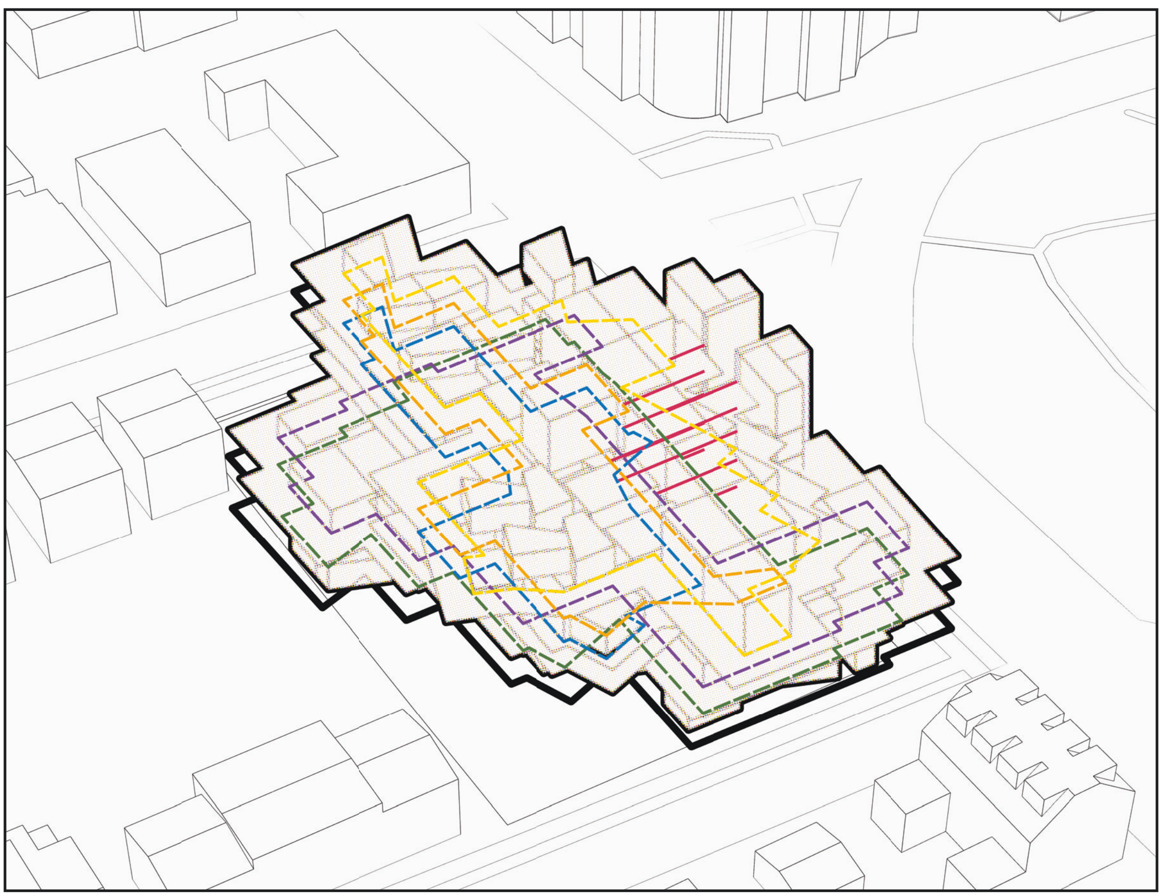
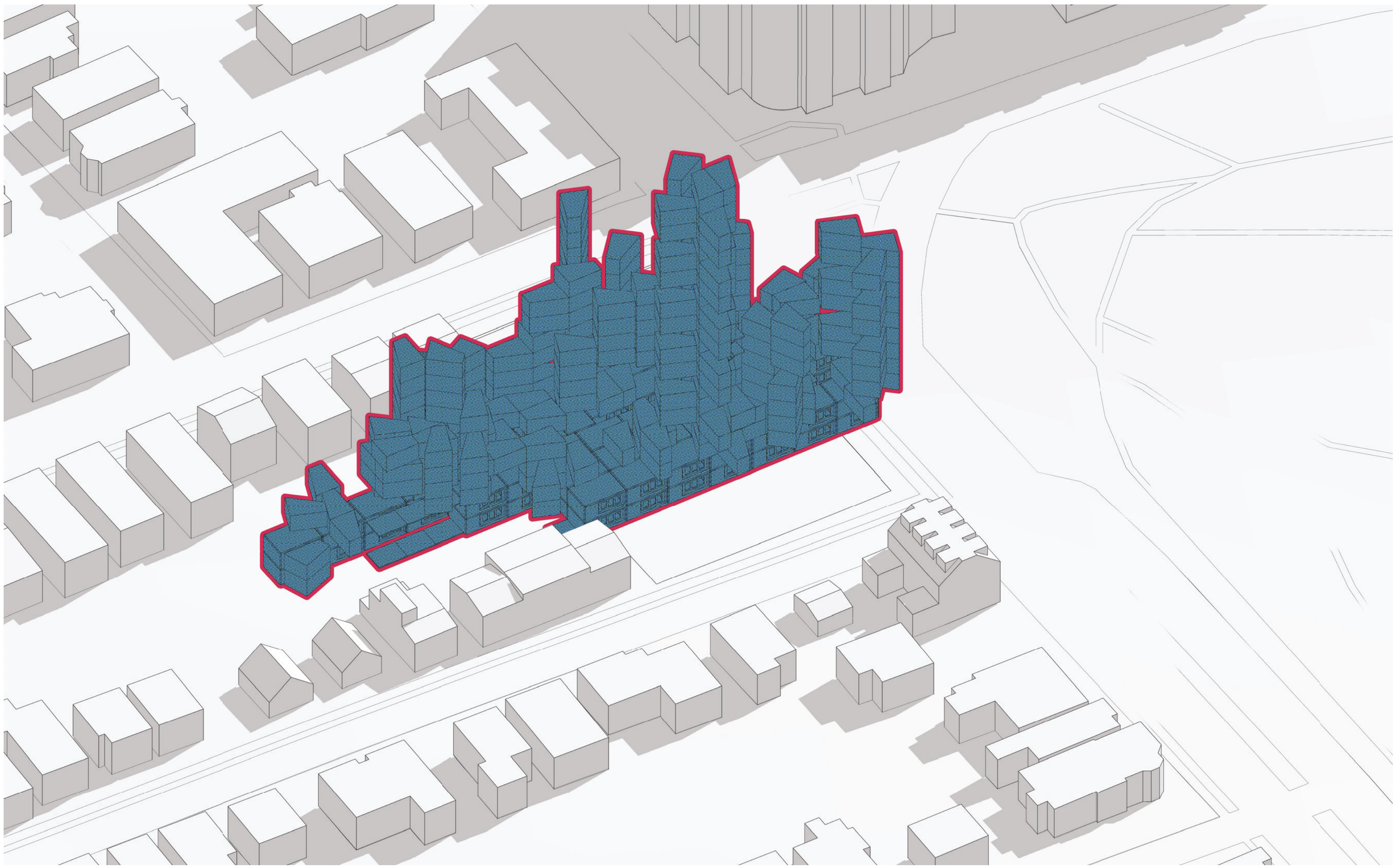
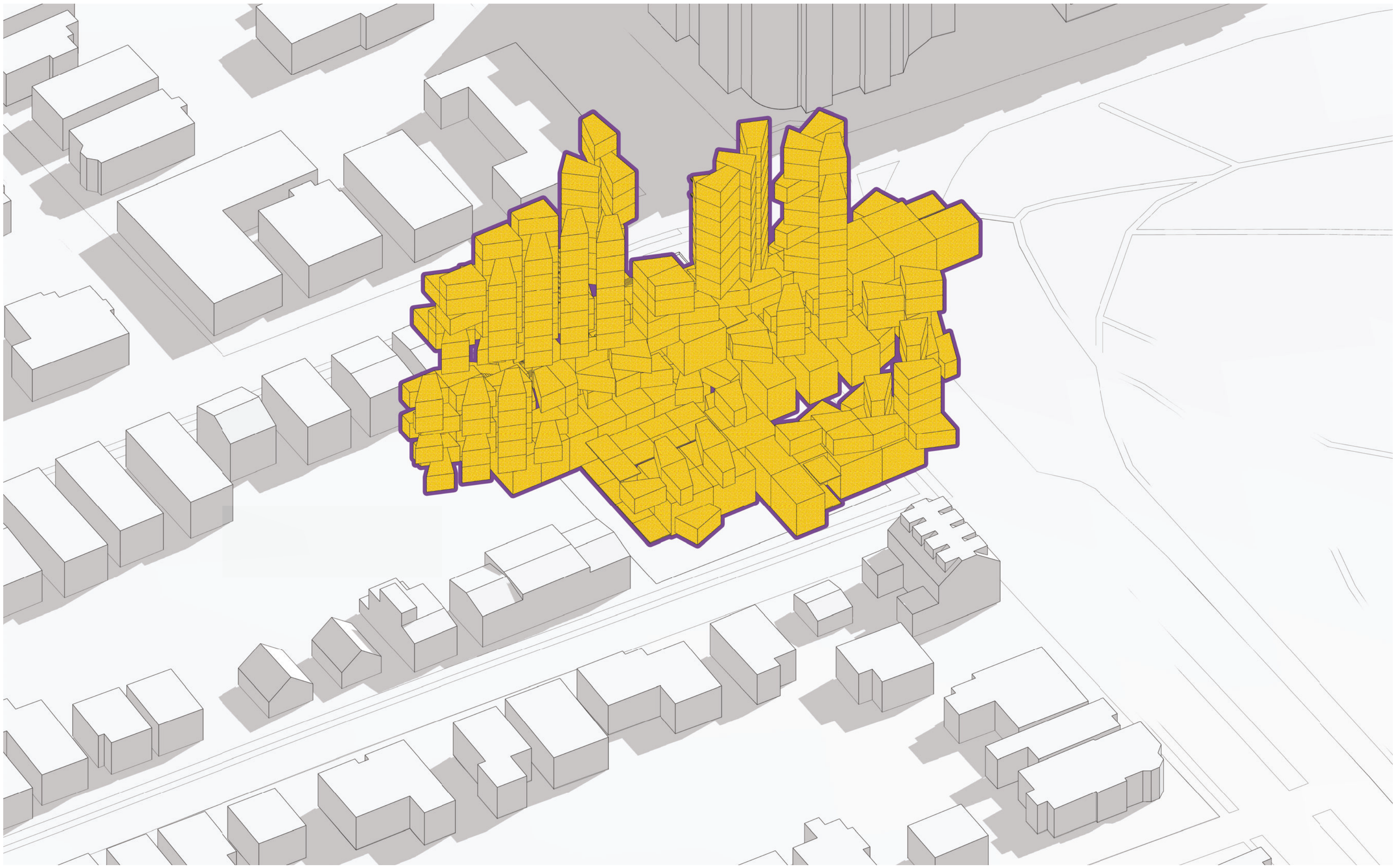


Diagram of services running through the underside of circulation platforms.

Massing Variation 01: Lower density, suggesting the possibility of connecting 2170 Robie Street to the Halifax Commons.

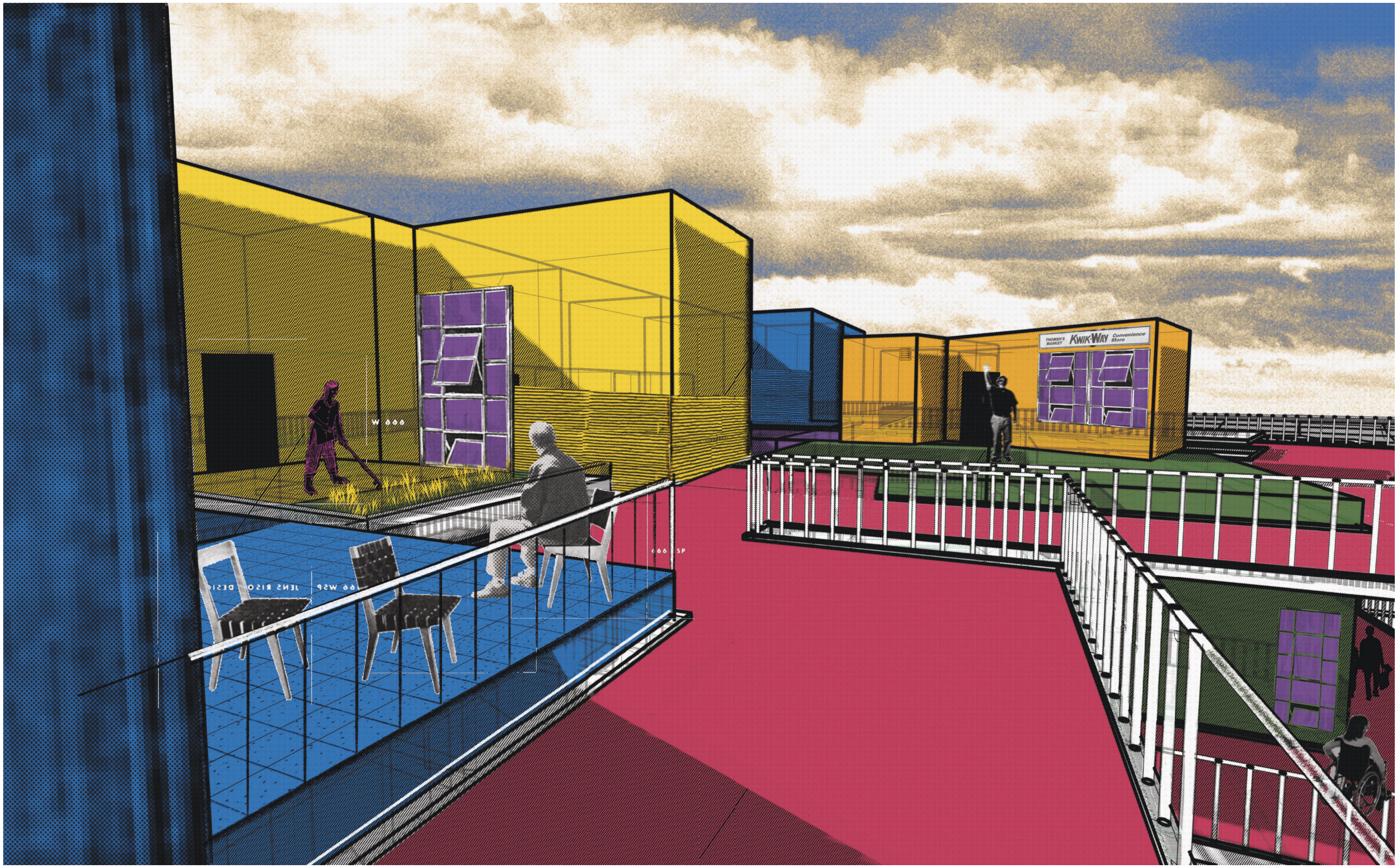


Massing Variation 02: Higher density option, using more backyard space outside of the site, and creating a South-facing plaza on Compton St.



Massing Variation 03: Highest density option, maximum units and least public space at ground floor, but great diversity of unit cluster.


View of design from Compton Street: Diversity of public space at the ground floor, connecting the development to the community.




View of pedestrian street circulation: Diverse human scale public space directly outside every unit and at every floor.

Interior Vignette: A comfortably sized living space, chosen for by the inhabitants for its unique criteria and manner of connection to context.

# Chapter 9: Conclusion

## Next Steps

At the end of many design projects there can be a feeling of incompleteness, of avenues not explored in the process. This thesis is no different, and as a process focused body of work lends itself well to further expansion. As such, there are several areas of this project that could benefit from more focused work, as well as a testing of the theories presented on a design-build project.

### 2170 Robie Street Continued

The design iteration presented as “final” at the thesis defence was not a complete building, rather a schematic counterpoint to geometric pre-rationalization and block-filling volumetric density. The primary guiding parametric intention of the iteration was Drifted spatial connections to create clusters of rooms with many criteria available for the inhabitants to choose from. Continuation of this work via more comprehensive fleshing out of the architectural systems surrounding the units could result in a stronger case study of alternative density and parametric process.

#### *Slower Growth*

The ability of parametric process to generate complexity rapidly, especially a Drift-centered parametric process, is a strength and a weakness. In growing an aggregation that takes up most of the site, there is perhaps an opportunity lost: the scalar relation of the unit clusters to the previously existing site volumes. Working with the same process but breaking down the cluster sizes, aggregating the aggregation, could develop into a more sophisticated response to the push and pull of density and open space. Study of a slower growth rate could also prove beneficial; working piece by piece. By adding some creative restraint to the work, space could be created in the building for inhabitation and personal design build projects by the residents, similar the Alejandro Aravena's housing projects in Chile.

### *Circulation and Units*

By breaking down the aggregated volume into further clusters, there arises a need and opportunity to utilize circulation spaces as an organizing element. Rather than working circulation into the aggregation after the clusters had already formed, a better process could involve subdividing the site with a pedestrian street (or streets), and then growing the aggregations off of those streets at each level. The size of each cluster would be smaller and more intimate. They would also be more unique as they could not all be relying on the same directional constraints: the software Wasp places parts based on the previously placed part so even though there is diversity in a site scale aggregation, individual clusters would have more complexity of orientation and geometry.

## The Results of the Process

The design variations presented in this document represent 7 months of work investigating the potential for productive Drift in the architectural process. Primarily concerned with the manifestation of imperfection at the scale of room to room spatial connection and through it the creation of diverse human-scale urban space, the resulting representations of inhabitation are a convincing argument that Drift can provide a catalyst within the design process that suggests alternatives to geometrically pre-rationalized parametric architecture. The timing of this thesis work is particularly interesting: the time that it was written happened to coincide with the first massive surge of AI utilization within the general populace. Artificial intelligence was not a focus within the thesis work, but it is not hard to see the connections: a digital tool that takes input dictated by a user and processes them into a result. Prompt-based design is already more accessible than standard node-based parametric design process, a trend that will continue while also increasing in capability and quality of result. This makes it all the more important that the processes by which designers utilize these tools are constantly re-evaluated (as well as the results). Some feel that the era of the creative might be coming to an end, but it is the opposite. Remarkable tools of both design and production are rapidly advancing, and alongside them the architectural profession must advance if the practitioners allow it to. The combination of digital production, parametric digital process, and Drift can create a beautiful, complex architecture that is stunning in construction and rich in diversity of space.

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